AFFTC-TR-96-17

HAVE CHRYSALIS LIMITED EVALUATION OF THE STEMME S10V (TG-11) MOTORGLIDER

AFFTC

DAVID W. HILTZ
Captain, USAF
Project Manager

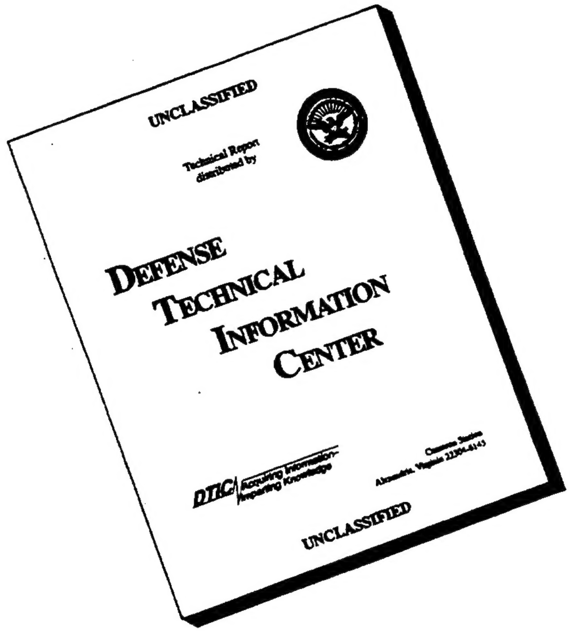
JUNE 1996

FINAL REPORT

Approved for public release; distribution is unlimited.

AIR FORCE FLIGHT TEST CENTER
EDWARDS AIR FORCE BASE, CALIFORNIA
AIR FORCE MATERIEL COMMAND
UNITED STATES AIR FORCE

DISCLAIMER NOTICE



THIS DOCUMENT IS BEST QUALITY AVAILABLE. THE COPY FURNISHED TO DTIC CONTAINED A SIGNIFICANT NUMBER OF PAGES WHICH DO NOT REPRODUCE LEGIBLY.

This technical report (AFFTC-TR-96-17, *HAVE CHRYSALIS Limited Evaluation of the Stemme S10V [TG-11] Motorglider*) was submitted under Job Order Number M96J0200 by the Commandant, USAF Test Pilot School, Edwards Air Force Base, California, 93524-6485.

Prepared by:

DAVID W. HILTZ
Captain, USAF
Project Manager

D. BRENT BAYSINGER
Captain, USAF
Project Pilot

GREGORY M. FOLCIK
Captain, USAF
Project Engineer

PETER J. HUGHES
Captain, USAF
Project Navigator

MARTIN G. ROLLINGER
Major, USMC
Project Pilot

This report has been reviewed and is approved for publication: 21 June 1996

ROGER C. CRANE
Chief Engineer, 412th Test Wing

JAMES H. DOOLITTLE III
Colonel, USAF
Commandant, USAF TPS

REPORT DOCUMENTATION PAGE

Form Approved
OMB No. 0704-0188

1. AGENCY USE ONLY *(Leave blank)*	2. REPORT DATE	3. REPORT TYPE AND DATES COVERED
	June 1996	FINAL, 2 through 26 April 1996

4. TITLE AND SUBTITLE

HAVE CHRYSALIS Limited Evaluation of the Stemme S10V (TG-11) Motorglider

5. FUNDING NUMBERS

JON: M96J0200

PEC: 65807F

6. AUTHOR(S)

Hiltz, David W., Captain, USAF, Project Manager
Rollinger, Martin G., Major, USMC, Project Pilot
Baysinger, D. Brent, Captain, USAF, Project Pilot
Hughes, Peter J., Captain, USAF, Project Navigator
Folcik, Gregory M., Captain, USAF, Project Engineer

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES

USAF TPS/EDB
220 S Wolfe Ave
Edwards AFB, California 93524-6485

8. PERFORMING ORGANIZATION REPORT NUMBER

AFFTC-TR-96-17

9. SPONSORING / MONITORING AGENCY NAME(S) AND ADDRESS(ES)

USAF TPS/EDT
220 S Wolfe Ave
Edwards AFB CA 93524-6485

10. SPONSORING / MONITORING AGENCY REPORT NUMBER

11. SUPPLEMENTARY NOTES

12a. DISTRIBUTION / AVAILABILITY STATEMENT

Approved for public release; distribution is unlimited

12b. DISTRIBUTION CODE

A

13. ABSTRACT *(Maximum 200 words)*

This report presents the flight test results of a limited evaluation of the Stemme S10V (TG-11) motorglider for the USAF Academy. The overall objective of the HAVE CHRYSALIS flight test program was to determine certain performance characteristics deemed critical to the USAF Academy soaring program. Flight testing consisted of performance takeoffs at Edwards AFB, California and Big Bear City Airport, Big Bear, California. The altitude required after losing an engine on takeoff to perform a 180-degree turn to land downwind was measured. Engine start procedures were investigated to determine the time required to restart the engine. Engine out landings were performed to qualitatively evaluate any flying qualities problems. Powered cruise and climb performance were also measured. The data were compared to the flight manual whenever possible.

14. SUBJECT TERMS

TG-11 aircraft	motorglider	glider
takeoff	performance	Stemme S10V

15. NUMBER OF PAGES

16. PRICE CODE

17. SECURITY CLASSIFICATION OF REPORT	18. SECURITY CLASSIFICATION OF THIS PAGE	19. SECURITY CLASSIFICATION OF ABSTRACT	20. LIMITATION OF ABSTRACT
UNCLASSIFIED	UNCLASSIFIED	UNCLASSIFIED	UNLIMITED

NSN 7540-01-280-5500

Standard Form 298 (Rev. 2-89)
Prescribed by ANSI Std. Z39-18
298-102

This page intentionally left blank.

PREFACE

This report contains the results of a limited performance and flying qualities evaluation of the Stemme S10V (TG-11) motorglider. Testing was requested by the USAF Academy as part of the USAF Test Pilot School's Test Management Phase Curriculum. The test was conducted at the Air Force Flight Test Center by a test team from the Test Pilot School Class 95B under Job Order Number M96J0200.

We are extremely thankful for the maintenance and technical assistance of Mr John Saunders, who deployed to Edwards AFB, California with the motorglider for more than a month. Thanks to John, the motorglider performed flawlessly. Special thanks goes to Mr Frank Brown for his many hours of great engineering guidance. Finally, we are grateful for the tireless efforts of Major Norm Howell. From constructing our theodilite to supporting several weekend missions, he gave us outstanding support. We literally couldn't have gotten off the ground without him.

This page intentionally left blank.

EXECUTIVE SUMMARY

This report presents the results of the HAVE CHRYSALIS flight test program of the Stemme S10V, designated the TG-11 motorglider from the Air Force Academy. HAVE CHRYSALIS was a limited performance test of the TG-11 aircraft for the USAF Academy's cross-country soaring program. Flight testing was conducted in April 1996 and consisted of 22 flights flown during 31.9 flight hours.

The TG-11 was a high performance, two place, side-by-side, motorglider with a 76-foot wingspan and an advertised 50:1 glide ratio. The motorglider was powered by a 93-horsepower Limbach engine driving a propeller which folded inside the nose cone when it was not being used.

The test program consisted of maximum gross weight takeoff, climb, and cruise performance. The altitude lost during engine restart and the altitude required after losing the engine on takeoff to perform a turn for a parallel downwind landing were found. Finally, some pilot comments were identified for the USAF Academy instructor program upgrade training program, primarily in the area of handling qualities.

Takeoff performance was measured at Edwards AFB, elevation 2,300 feet, and Big Bear City, California, elevation 6,750 feet. Takeoff ground roll distances and distances to 50 feet were standardized to pressure altitudes of 3,280 and 6,560 feet (1,000 and 2,000 meters). Results revealed up to 11 percent greater distance in ground roll and 32 percent greater distance to 50 feet for both altitudes in comparison with the flight manual. In the area of handling qualities, performing a coordinated turn in the TG-11 was difficult and required practice to perform properly. Climb performance, found to be between 300 to 350 feet per minute at the tested altitudes, was difficult to repeatably obtain due to the TG-11's extreme sensitivity to atmospheric lift and sink. The engine loss after takeoff tests showed the optimum bank angle was 45 degrees and resulted in an average of 130 feet lost in the 180-degree turn. Limited testing performed with the propeller braked (but not centered) indicated the altitude lost was reduced to just 80 feet. The only test objective not fully met was the altitude loss for engine start due to large scatter in the data. Despite the scatter, altitude losses for engine starts were realistic and adequate safety margins could be attained by using the worst case 2-sigma altitude loss from this investigation. This would yield an altitude loss of 950 feet. Cruise performance, specific range, at 2,500 rpm was found to be 22 to 24 nautical air miles per gallon between 7,500 and 9,500 feet for standard day conditions.

The USAF Academy should incorporate these flight test results into their TG-11 Flight Manual. The TG-11 was an excellent high performance glider. It was also a low-performance powered aircraft with some unique handling qualities. Steep turns required the pilot's undivided attention to control airspeed and bank angle. The USAF Academy training program should include repeated coordinated turn and steep turn practice. Extreme care is needed when the motorglider is in sink since climb performance is extremely degraded. Finally, additional testing is recommended for statistical significance to quantify the advantage of braking the propeller if the engine were lost after takeoff and the altitude loss during starting the engine. Overall, sufficient performance data was collected to allow the Academy to evaluate the performance suitability of the TG-11 for their cross-country soaring program.

This page intentionally left blank.

TABLE OF CONTENTS

TABLE OF CONTENTS (Concluded)

LIST OF ILLUSTRATIONS

LIST OF TABLES

LIST OF TABLES (Concluded)

This page was intentionally left blank.

INTRODUCTION

GENERAL

This report presents the results of the HAVE CHRYSALIS flight test program of the Stemme S10V motorglider, designated the TG-11 aircraft from the Air Force Academy. Twenty-two sorties were required to complete this evaluation between 2 and 26 April 1996. The 32-hour flight test program consisted of 8 hours of checkout and practice, 21 hours of flight testing, and 3 hours for ferry flights to Big Bear City Airport, California. This evaluation was conducted by students of the Test Pilot School (TPS), Edwards AFB, California and funded under Air Force Flight Test Center Job Order Number M96J0200. All flights were flown from either the Air Force Flight Test Center at Edwards AFB, California or from Big Bear City Airport, Big Bear, California.

BACKGROUND

The TG-11 aircraft was a two seat, side-by-side motorglider which had been certified in Europe as the Stemme S10V and complied with FAA regulations. The motorglider was first evaluated by the Air Force Flight Test Center (AFFTC) for the United States Air Force Academy (USAFA) on November 3, 1994. Test pilot Lieutenant Colonel Jim Payne flew one flight at the contractor's facility at Strausberg, Germany. He recommended the USAFA purchase the S10V motorglider and for the USAF to conduct operational tests to verify the flight manual data.

The USAFA purchased two commercial, off-the-shelf Stemme S10V Chrysalis motorgliders (USAF designation was the TG-11 aircraft). The USAFA plan to use the glider as a cross-country soaring trainer, with the ability to self-recover to prevent landing away from home. Prior to the start of the HAVE CHRYSALIS testing, Major Norm Howell, a test pilot from the USAFTPS, performed five qualitative evaluation flights at the USAFA between 5 and 9 February 1996. These flights primarily investigated the stall characteristics of the motorglider. The motorglider was classified as spin resistant from the Phase B stall tests which were conducted with both one and two pilots. The results from these flights are not included in this report.

The USAFA requested a spot check of the flight manual in the areas of takeoff, climb, and cruise performance. They were also interested in the altitude lost while restarting the engine and the minimum altitude above ground level at which the engine could be lost after takeoff and allow a 180-degree turn to be made for a parallel downwind landing. This report presents results of these flight tests.

TEST ITEM DESCRIPTION

The TG-11 aircraft was a commercial, off-the-shelf, two-seat Stemme S10V motorglider built by Stemme GmbH & Co., Strausberg, Germany, and met applicable Federal Aviation Regulations (FARs). The motorglider will be referred to as the TG-11 aircraft in the remainder of this report. The high performance glider was self launched with a Limbach L-2400 EB1.D, 4-cylinder, air-cooled, 93-horsepower engine and was advertised to cruise at 120 knots. The engine's fuel mixture was automatic (self adjusting). The TG-11 was equipped with a retractable landing gear and the propeller was configured with two jointed blades which folded inside the nose cone when not in use. The glide ratio was advertised to be 50:1. The aircraft weight and dimensions are shown below in Table 1.

Table 1
TG-11 AIRCRAFT WEIGHT AND DIMENSIONS

Length: 28 ft	Max Gross Wt: 1,874 lb
Height: 6 ft	Empty Wt: 1,454 lb
Wing Span: 76 ft (folded: 37 ft)	

The TG-11 aircraft was equipped with a manifold pressure gauge, total air temperature gauge (approximately ambient air temperature), and a fuel flow meter. Additional information on the motorglider was contained in the Stemme S10V Flight Manual, (Reference 1). Photographs of the motorglider are found in Appendix F. A 3-view drawing of the TG-11 aircraft is presented in Figure F5.

TEST OBJECTIVES

The general objective was to provide the USAFA with sufficient performance data to allow them to evaluate the TG-11 aircraft as a cross-country soaring trainer for their USAFA soaring program. A limited evaluation of performance and flying qualities was performed for takeoff, engine-out landings, powered climb and cruise performance. These results were compared to the manufacturer's flight manual whenever possible. The detailed objectives were as follows:

1. Determine takeoff distance and distance to clear 50 foot obstacle for zero winds, zero slope, and maximum gross weight at 3,280 and 6,560 feet pressure altitude[1].

2. Determine altitude lost while transitioning from gliding to powered flight.

3. Determine the minimum altitude at which an engine could be lost on takeoff and the glider could be safely maneuvered for a parallel downwind landing and estimate decrease in altitude lost by braking the propeller.

4. Determine climb performance based on the flight manual best rate of climb schedule between 3,000 to 10,000 feet pressure altitude with the propeller in the takeoff position, maximum continuous power, flaps at the +5 setting, and cooling flaps full open.

5. Determine specific range at 8,500 feet with propeller and flaps in the cruise configuration at 2,500 rpm and maximum gross weight.

All objectives were met.

[1] All altitudes in this report are pressure altitude if not otherwise identified.

TEST AND EVALUATION

TAKEOFF

Takeoff Procedures:

The objective of the takeoff testing was to spot check the flight manual maximum gross weight predictions of ground roll and distance to 50 feet at standard day conditions for 3,280 and 6,560 feet (1,000 and 2,000 meters) respectively. The USAF Academy had noticed considerably longer distances than predicted for the higher density altitudes and desired accurate data for their TG-11 glider training program. Representative altitudes were achieved by conducting tests at Edwards AFB and Big Bear City Airport, CA. The Big Bear City Airport elevation closely matched that of the Academy's airfield, 6,750 feet compared to 6,570 feet for the Academy.

Takeoff procedures were in accordance with the TG-11 flight manual (Reference 1) with the exception of climbout speed. Full throttle was smoothly applied with the brakes held and the stick in the neutral position. The tail was raised at 35 knots indicated airspeed with liftoff performed at 46 knots indicated airspeed. The aircraft was then accelerated horizontally to climbout speed at approximately 10 feet above ground level. A climbout speed of 56 knots (best angle of climb speed) was used by the test team to better determine the aircraft's obstacle clearance potential after liftoff. The flight manual was based on a indicated climbout speed of 62 knots (best rate of climb speed). Distance to takeoff and distance to 50 feet were measured by two ground crews. Ground station 1 measured ground roll distance and time from brake release, as well as ambient weather conditions. Ground station 2 measured the time and distance from brake release to clear 50 feet. A detailed description of the equipment setup procedures, as well as each teams responsibilities are explained in Appendix A. Table A1 shows the data parameters collected by each team.

Data reduction was in accordance with procedures described in the May 1982 Corrigendum to *Standardization of Take-Off Performance Measurements for Airplanes* (Reference 2) and the *Flight Test Engineering Handbook* (Reference 3). Specific reduction formulas are listed in Appendix A. Data from each takeoff were adjusted to zero wind and runway slope before being standardized to the aircraft's maximum gross weight (1,874 pounds) at standard day conditions. Results at Edwards AFB were standardized to 3,280 feet (1,000 meters) and the data from Big Bear City Airport were standardized to 6,560 feet (2,000 meters). Takeoff distances and distances to 50 feet were then averaged and analyzed for their statistical significance using the Student's t distribution. A comparison was then made with flight manual values. Finally, a Student's t value of 1.35 was multiplied by the standard deviations and then added to the averages. The factor of 1.35 was calculated by performing a single tailed Student's t test about the mean with a 90 percent confidence level. The resulting value provided a statistical confidence that 90 percent of all takeoffs would be less than or equal to the stated distances. The increased distances were provided as a safety factor.

The takeoff data reduction formulas used in this evaluation were intended to standardize the data to an altitude similar to the test day pressure altitude. The 6,750-foot field elevation at Big Bear City Airport was an acceptable proximity to the standardized altitude of 6,560 feet. The 2,300-foot field elevation at Edwards AFB, however, was nearly 1,000 feet lower than the 3,280-foot standardized altitude. To evaluate the validity of the standardization to 3,280 feet, a comparison was made between the standardized performance at 6,560 feet (based upon results obtained at Edwards AFB) and the standardized results at 6,560 feet (based upon results obtained at Big Bear City Airport). In this manner, an error approximation was made of the standardization from 2,300 to 6,560 feet by comparing the differences between the two standardized performance results for 6,560 feet.

Takeoff Results:

The test objective was met. Raw data and reduction of takeoff data are tabulated in Appendix B. The overall averages for each distance at both test locations, along with their statistical relevance, are shown in Table 2. The presented values have been

Table 2
OVERALL TG-11 STANDARDIZED TAKEOFF DISTANCE AND DISTANCE TO 50 FEET RESULTS

Standard Day Results at 3,280 ft	Number of Measurements	Average Distance (ft)	Standard Deviation (ft)	95 Percent Confidence Range[1] (ft)
Takeoff Distance	14	1,090	132	±76
Distance to 50 ft	14	2,620	121	±70
Standard Day Results at 6,560 ft				
Takeoff Distance	14	1,775	97	±56
Distance to 50 ft	14	3,395	174	±100

Note: Presented values are for a 1976 U.S. Standard Atmosphere for maximum gross weight (1,874 pounds) at zero wind and runway slope.

[1]Confidence that the population mean lies within the specified range.

rounded up to the nearest 5-foot interval from the standardized results. Most of the ground distances at the Edward's location were within 150 feet of each other and with five measurements within 200. The ground distances at Big Bear were even more consistent, yielding the lowest standard deviation. The distances to 50 feet, however, were fairly scattered and had upwards of 400 feet difference in measured distances. Overall, the test plan success criteria of a 95-percent confidence level that the population mean lie within the range of ±100 feet of the sample mean was met.

Validity of Data Reduction Technique.

Differences between predicted and actual takeoff performance at 6,560 feet are displayed in Table 3. The predictions are based upon measurements taken 4,450 feet below the standard altitude. The predicted performance in Table 3 are from the data acquired at Edwards AFB, at an airfield elevation of 2,300 feet, and standardized to a pressure altitude of 6,560 feet. Separate standardization formulas were used for ground distances and distances to 50 feet. Each formula can be found in Appendix A. The data acquired at 2,300-feet and then standardized to 6,560 feet were 21 percent longer than the distances actually obtained at 6,750 feet and standardized to 6,560 feet. This illustrates a limitation of this data standardization technique. The 1,000 feet altitude difference between the airfield elevation at Edwards AFB and the 3,280-foot standard altitude, represents 22 percent of the total altitude difference between Edwards AFB and 6,560 feet. If the standardization error at 3,280 was assumed to be equal to the same fraction (22 percent) of the total errors at 6,560 feet, a maximum of 5 percent of error (22 percent of 21 percent) was suspected for results standardized to 3,280 feet. The percentage equates to distances less than 100 feet. This suggests that standardization from 2,300 to 3,280 feet was valid considering the error introduced by the standardization was less than the 200 feet of measurement dispersion recorded at Edwards AFB.

A standardization error approximation was also calculated by comparing ambient air density ratios between the Edwards AFB test day conditions and the standard day densities of 3,280 and 6,560 feet. The average test day density ratio at Edwards AFB of 0.9229 was divided by the standard day density ratios at 3,280 and 6,560 feet, 0.9074 and 0.8216, respectively. The difference between these two fractions was divided by the ratio of the Edward's test day density ratio to the 6,560-foot standard day density ratio. The resulting standardization error approximation was 9.45 percent, which was less than half the standardization error approximation made by comparing pressure altitude differences.

Flight Manual Comparison.

The ground roll distance at 3,280 feet with standard day conditions was 4.3 percent shorter than the flight manual predictions, while the ground roll distance at 6,560 feet was 11 percent longer than the flight manual predictions. Distances to 50 feet, however, were as much as 32 percent longer than predicted. Tables 4 and 5 summarize the comparisons for both altitudes. Values which

Table 3
COMPARISON OF TG-11 PREDICTED AND ACTUAL TAKEOFF DISTANCES AT 6,560 FEET

	Predicted Distance[1] (ft)	Actual Distance[2] (ft)	Difference[3] (ft)	Percent Difference[4]
Takeoff Distance	1,406	1,775	369	21
Air Distance	1,944	-1,620	-324	-20
Distance to 50 ft	3,350	3,395	45	1

Notes: Standard day, zero wind, and zero runway slope at 1,874 pounds

[1]Prediction based upon results measured at a 2,300-foot field elevation
[2]Actual based upon results measured at a 6,750-foot field elevation
[3]Difference = Actual - Predicted
[4]Percent difference = (difference / actual distance) X 100

provide a 90 percent confidence level that actual takeoffs will occur in less distance than those stated are presented as safety factors for the USAF Air Force Academy. **The USAF Air Force Academy should use the HAVE CHRYSALIS test results for takeoff groundroll distance and for distance to 50 feet for their TG-11 aircraft training program. (R1)[2]**

It is important to remember that the stated results are for zero wind and slope conditions. The reduced data represents samples recorded in calm wind conditions. The test team noticed considerable takeoff performance improvement in strong headwind conditions at Big Bear City Airport on the first day of testing. Three takeoffs were performed with a 15-knot headwind. The temperature was 50 degrees Fahrenheit with a pressure altitude of 6,520 feet. The takeoff distance of 1,000 feet on each attempt was nearly 500 feet lower than the shortest distance recorded in calm winds. The distance to 50 feet in this condition was not recorded due to excessive repositioning of the theodolite.

PILOT COMMENTS

Background:

A general objective of the test program was to have the pilots comment on the TG-11's general operational handling qualities during an FAA checkout program in order to highlight any areas that would warrant increased emphasis in the USAFA Instructor Pilot Training Syllabus. The two test pilots that participated in HAVE CHRYSALIS did not have previous extensive light airplane experience. Captain Baysinger was a B-1B pilot with over 1,700 hours in military jet aircraft. Major Rollinger was a United States Marine Corps fighter pilot with over 3,000 flight hours in military jets. The pilots were given specific light aircraft and glider flight training in preparation for test flying the TG-11. The light aircraft training, a total of 4.5 flight hours, was flown in a two-place tail wheel Cessna 150. The pilots both flew approximately 8 hours divided among four different types of gliders, including the ASK 21, in preparation for evaluating the TG-11.

The test pilots flew a two flight training flight syllabus in the TG-11 with an instructor pilot before they participated in-flight test operations. The test pilots made observations and recorded comments regarding unique aircraft characteristics and handling qualities that could impact TG-11 flight operations. These two test pilots were uniquely qualified to accomplish this task because they did not have extensive light aircraft experience that would allow them to instantly and instinctively react to the TG-11 and compensate for any marginal handling qualities they may have discovered. The test pilot comments along with recommendations were recorded on the Daily Flight Reports and are included in Appendix I.

Pilot Comments:

The TG-11 was an excellent high performance glider. It was also a low performance powered aircraft with some unique handling qualities. Overall, the TG-11 was well suited for the USAFA soaring program.

[2] Numerals preceded by an R within parentheses at the end of a paragraph correspond to the recommendation numbers tabulated in the Conclusions and Recommendations section of this report.

Table 4
TG-11 STANDARD DAY TAKEOFF COMPARISON TO FLIGHT MANUAL VALUES

Pressure Altitude (ft)	Standardized Takeoff Distance (ft)	Takeoff Distance (Flight Manual) (ft)	Difference (ft)	Percent Difference[1]	90 Percent Confidence Value[2] (ft)
3,280	1,090	1,138	-48	-4.3	1,270
6,560	1,775	1,578	197	11	1,910

Note: Presented values are valid for maximum gross weight (1,874 pounds) at zero wind and runway slope

[1]Test - Flight Manual/Test x 100
[2]Ninety percent confidence that takeoffs will be less than the stated distance

Table 5
TG-11 STANDARD DAY DISTANCE TO 50 FEET COMPARISON TO FLIGHT MANUAL VALUES

Pressure Altitude (ft)	Standardized Distance to 50 Feet (ft)	Distance to 50 Feet (Flight Manual) (ft)	Difference (ft)	Percent Difference[1]	90 Percent Confidence Value[2] (ft)
3,280	2,620	1,791	829	32	2,785
6,560	3,395	2,484	911	27	3,630

Note: Presented values are valid for maximum gross weight (1,874 pounds) at zero wind and runway slope

[1]Test - Flight Manual/Test x 100
[2]Ninety percent confidence that takeoffs will be less than the stated distance

Seat Cushion.

The cockpit of the TG-11, however, was small and somewhat cramped. One test pilot noted that when the canopy was lowered that it would come in contact with the top of his head. This pilot had a standing height of seventy two inches. The pilot would attempt to slide down in his seat to lower his head a few centimeters and in doing so the seat cushion would come in contact with the control stick. This did not impair stick movement during takeoff or cruise flight. The seat pad did contribute objectionable resistance to stick movement in the landing flare. The pilot thought that the other crew member was interfering with the aft movement of the control stick. **The seat cushions should be held in place such that they cannot slide forward. (R2)**

Takeoff.

The TG-11 propeller rotates counter-clockwise as viewed from the cockpit. In most American made propeller-driven aircraft the propeller rotates clockwise. The test pilots noted that the TG-11 had a definite tendency to yaw right as the nose was rotated down to takeoff attitude on the takeoff roll. This was opposite the direction of yaw that is experienced by aircraft that have the propeller rotating the other way. The cause for the yaw was gyroscopic precession. The test pilots were trained in tail wheel aircraft prior to flying the TG-11. The yawing motion opposite from what they had gotten used to caused considerable directional control difficulties in the first few takeoffs.

Turn Coordination.

The pilots found that steep turns were difficult to control precisely. Proper turn coordination required rapid and repeated cross check of the canopy yaw string, requiring constant pilot attention in all but the shallowest of turns. The aircraft had a tendency to continue rolling into the turn any time the bank angle was greater than approximately 30 degrees. The overbank tendency increased as the aircraft bank angle increased. This tendency was not unusual for gliders or other aircraft that have such a large wingspan.

The pilots sat next to each other, symmetrical about the aircraft's centerline, vice straddling the longitudinal axis like they would in a single seat or

tandem seat aircraft. The pilots found that they tended to fly the same sight picture (glare shield placement on the horizon) when they were turning right as when they were turning left. This technique allows precise attitude control in an aircraft where the pilot is sitting on the centerline of the aircraft, but it does not facilitate precise control when the pilots are offset from the aircraft centerline. The pilots found that if they flew a constant altitude turn in one direction and then reversed the direction of turn they would tend to either climb or descend as they attempted to keep the same sight picture. This combined with the lack of any artificial horizon reference, the overbanking tendency and the difficult turn coordination made precise aircraft control difficult in steep turns. This could have grave consequences if the pilot were attempting to fly the aircraft back to the runway after a low altitude engine failure. Even at several thousand feet above the ground an improperly flown steep turn could result in loss of an aircraft and lives if the aircraft entered a spiral or an unusual attitude.

The TG-11 had very slow roll response. Takeoff and landing in any crosswind required rapid and at times full deflection roll control inputs to keep the wings level. Due to the long flexible wings, very little angle of bank (less than 5 degrees) at low altitude could result in a wingtip contacting the ground. **The TG-11 should be modified with scrape strips on the underside of the wingtips. (R3)**

Airstarts:

When the pilots performed the airstart procedure the aircraft got very noisy beginning with starter engagement and when the propeller was windmilling. The difference in noise level in the cockpit between the propeller just windmilling and when the engine was and the engine started was very slight and hardly noticeable. When engine start was unsuccessful the noise level in the cockpit did not decrease noticeably, due to the windmilling propeller. The performance of the engine was such that it was not immediately obvious to the pilots when it had begun producing thrust, especially at high density altitudes. The test pilots could only be sure the engine was running by referencing the engine rpm gauge and the electrical system charge light. It was not immediately apparent that an engine start was unsuccessful. This situation could lead to an aircraft mishap should the crew become distracted and not follow the checklist (forgetting to lift the ignition switch) or should the engine actually fail to start.

The preliminary TG-11 Flight Manual should be updated to include the following advisories as Cautions, Notes, or Warnings:

1. The seat cushion can impair the ability of the pilot to make control stick inputs.

2. The pilot should expect the aircraft to yaw right, requiring considerable left rudder to counter, when the aircraft nose is rotated down during the takeoff roll.

3. Steep turns in the TG-11 require undivided pilot attention to maintain coordinated flight and controlled airspeeds.

4. Wingtip ground clearance requires constant pilot attention at low altitude. The aircraft should not be operated from runways where the wingtips overhang runway equipment (runway lights, runway signs, etc.).

5. The only way the pilot can be sure that the engine is operating after an attempted airstart is by observing the rpm gauge and charge light. (R4)

The USAFA TG-11 training syllabus should include the following areas:

1. Several turn coordination and steep turn drills repeated on multiple flights.

2. Demonstrate that the only way the pilot can be sure that the engine is operating after an attempted airstart is by observing the rpm gauge and charge light. (R5)

SAWTOOTH CLIMBS

Climb Procedures:

Sawtooth climbs through a pressure altitude band were made to establish the best airspeed at which to climb and the corresponding rate of climb. A series of climbs were made at altitudes of 1,000, 2,000, and 3,000 meters pressure altitude at 56, 59, 62, 65, and 68 KIAS.

Climbs were performed at 3000 rpm (maximum continuous power) and at full throttle with the propeller in the takeoff position, flaps at the +5 setting, and the cooling flaps full open. The flight manual climb performance data were based on full throttle. The altitude increment was chosen such that the aircraft would traverse it in about 1 minute. Sawtooth climb test points detailing the 1 minute altitude increments and airspeeds flown are illustrated in Table 6. Climbs were confined to a limited geographical area and performed 90 degrees to the wind to minimize the effects of vertical winds and horizontal wind shears. Airspeed was held stable (±1 KIAS) throughout the data band or the data were not used.

Table 6
CLIMB TEST POINTS

Target Altitude (ft)	3,280 (1,000 m)	6,560 (2,000 m)	9,840 (3,000 m)
Test Pressure Altitude Increments (ft)			
1-Minute Increment	3,000	6,300	9,600
	3,110	6,400	9,680
	3,220	6,500	9,760
	3,330	6,600	9,840
	3,440	6,700	9,920
	3,550	6,800	10,000

Notes: 1. The test airspeeds were 56, 59, 62, 65, and 68 KCAS
2. The shaded portion represents the altitude band for a 1-minute climb.

The aircraft was trimmed in the climb configuration while still below the nominal start altitude. Power was applied and final trim adjustments were made before reaching the lower limit of the altitude band being measured. Indicated airspeed, weight, time, fuel counts, and total air temperature were recorded at the selected points in the data band. The elapsed time in the altitude band was recorded by stopwatch.

A running plot of observed time to climb versus indicated airspeed was kept during the flight and examined in order to better define the best climb speed and determine if any points needed repeating. Data at the bucket of the curves were reduced to determine the best rate of climb at the corresponding airspeed.

Climb Results:

Seven sawtooth climbs were performed at each of the three altitudes at a power setting of 3000 rpm. After three full climb profiles were performed at each of the target altitudes it became evident that the best climb speed was 62 knots. The remainder of the climbs were performed at the 62-knot best rate of climb speed. The flight test data used to determine the best rate of climb speed are presented in Figures C1 through C9. The times required to climb through the altitude band were exceeding 1 minute so the altitude band was modified and is represented by the shaded portion of Table 6. The average rate of climb for the three target altitudes is presented in Table 7. The TG-11 was very susceptible to lift, sink, and windshear due to the low wing loading. The wing loading of the TG-11 at 1,874 pounds was 9.3 pounds per square foot. The majority of the climbs were performed in the early morning but atmospheric effects still produced a significant amount of scatter in the test results. The minimum rates of climb experienced were 284, 220, and 128 feet per minute at 3,280, 6,560, and 9,840 feet, respectively. **A warning should be placed in the TG-11 flight manual discussing the aircraft's degraded climb performance in the presence of descending air. (R6)**

The altitude band was divided into six increments and the data were reduced producing six rates of climb for each climb. This was done to see if portions of the climb profile were effected by lift or sink. The majority of the data correlated so the entire climb profiles were effected by either lift or sink. The data presented in Table 7 are the average of the six altitude increments within the seven climb profiles performed. Rate of climb data for the 42 data points are presented in , Tables C2 to C4 and Figure C10.

The flight test rate of climb data were obtained at a lower power setting (3,000 rpm) and therefore could not be directly compared to flight manual data. A limited full throttle climb investigation was performed. Two climbs were performed at 3,280 and at 6560-foot target altitudes. The full throttle data presented in Table 7 are the average of six altitude increments within the two climb profiles performed. Tables C5 and C6 and Figure C11 present flight test

full throttle climb data. Full throttle produced 3,200 rpm at the two test altitudes. The ambient air temperatures at 3,280 and 6,560 feet were 73 and 60 degrees Fahrenheit, respectively. Figure C12 presents the flight test and flight manual rates of climb.

Table 7
CLIMB RESULTS

	Rate of Climb (ft/min)		
Pressure Altitude (ft/m)	Flight Manual	Max Power Test Results[1]	MCP Test Results[2]
3,280 (1,000 m)	552	414	353
6,560 (2,000 m)	493	331	307
9,840 (3,000 m)	394	NP	216

Notes: 1. Flight test rate of climb data are an average of all data obtained
2. Propeller pitch position: TAKEOFF, Flaps: +5
3. NP - not performed
4. MCP - maximum continuous power

[1]Data based on maximum takeoff weight, maximum takeoff power (full throttle), and climb speed of 62 knots.
[2]Data based on maximum takeoff weight, maximum continuous power (MCP) of 3,000 rpm, and climb speed of 62 knots.

ENGINE LOSS AFTER TAKEOFF

Engine Loss After Takeoff Procedures:

These patterns were flown in the takeoff configuration (landing gear extended, flaps +5 degrees, cooling doors open) near the Academy field elevation of 6,700 feet. A buildup approach was used to first determine the optimum pattern bank angle to fly, then determine the altitude lost while flying that pattern. The bank angle investigation was flown with the engine at idle. The majority of the investigation to determine altitude loss was also flown with the engine at idle to minimize the number of engine starts in flight.

The procedure was flown at best glide range speed of 57 knots indicated airspeed (±5 knots). Bank angle and heading indications were based on pilot estimates since there were no cockpit gyroscopic instruments. The test director recorded total air temperature and aircraft gross weight before commencing the procedure. The test director then recorded starting altitude and airspeed while the pilot noted an outside reference that could be used to determine a 180-degree turn (section line, runway, etc.) and started his turn. After the aircraft was rolled out wings level, final altitude and airspeed was recorded. Data were considered valid if airspeed was varied by less than 5 knots and the variometer indicated no more than 100 feet per minute lift or sink.

Corrections to observed altitude losses were performed for nonstandard day temperatures and airspeed changes during the procedure. Corrections for changes in aircraft gross weight were not necessary since the aircraft speed polar (Reference 1) showed negligible effects of gross weight below 70 knots (at 70 knots, sink rate varied from 150 to 160 feet per minute through the entire gross weight envelope of the aircraft). Error introduced by variations in altitude, since this was a gliding procedure, was sink rate being based on true airspeed rather than calibrated airspeed ($V_{sink}=V_{true}\ \mathrm{Sin}\gamma$, where γ is the glider flight path angle). All testing was performed below 10,000 feet MSL and the TG-11 was a very high performance glider (γ between 1 and 2 degrees) so these errors were considered negligible. The correction for test day ambient air temperature difference from standard day was (Equation 5.28, Reference 4):

$$\Delta h = (T_a/T_s)\,\Delta h_C$$

Where:

Δh = Geopotential (actual) altitude change

Δh_C = pressure altitude change

T_S = Standard day ambient air temperature

T_a = Test day ambient air temperature

The correction for airspeed changes was (Equation 9.11, Reference 5):

$$\frac{dE_S}{dt} = \frac{dh}{dt} + \frac{VdV}{gdt}$$

Where:

E_s = Energy (Sum of kinetic and potential energy)

V = True Airspeed

g = Acceleration due to gravity

This equation was used to determine total energy change of the aircraft and was then solved for a constant true airspeed descent by setting the dV/dt term equal to zero.

Engine Loss After Takeoff Test Results:

Seventeen 45-degree patterns were flown with the landing gear extended, engine at idle, propeller windmilling and flaps set at five degrees as shown in Table D1. The mean altitude lost while flying this pattern was 130 feet. The standard deviation for these patterns was 20 feet. With these figures using the Student's t distribution, the 95 percent confidence interval was ±11 feet (8.7 percent of the sample mean). This altitude loss did NOT take into account any reaction time on the part of the pilot or any altitude required for ground clearance of the wingtips. In addition, the horizontal distance traveled after takeoff before this altitude was attained might affect the decision to attempt to turn back to the takeoff field or continue straight ahead for landing.

An investigation to determine optimum bank angle for a turn to downwind pattern was conducted and the results are shown in Table 8. The 60-degree pattern was flown only once to the required airspeed tolerances. This pattern was extremely difficult to fly properly due to the strong tendency of the TG-11 to overbank when using greater than 45 degrees of bank and the limited aft stick authority available to keep the nose from dropping at high angles of bank. **A bank angle of 45 degrees should be used to turn downwind following an engine failure during the takeoff climbout. (R7)**

Table 8
EFFECT OF BANK ANGLE ON
180-DEGREE PATTERN

Bank Angle (deg)	Altitude Lost (ft)
30	200
45	129
60	126

Note: All patterns flown during the bank angle investigation were in the landing configuration with engine at idle.

Several patterns were flown with the engine shut down and the propeller windmilling, as well as with the engine shut down and the propeller braked (but not centered and stowed). Not enough patterns were flown to demonstrate statistical significance, but an interesting trend can be seen in the data shown in Table D1. Simply shutting the engine down decreased the average altitude loss to 110 feet (with a sample size of three patterns) and braking the propeller further decreased the average to 80 feet (with a sample size of five patterns). This would suggest that with the engine running at idle it was providing a small amount of drag to the aircraft. This also seemed to confirm that the drag of the aircraft was increased significantly with the propeller windmilling. **Further investigation of performance benefits from braking propeller and possible incorporation of guidance into engine failure on takeoff checklist should be accomplished. (R8)**

ALTITUDE LOSS FOR ENGINE START

Altitude Loss for Engine Start Procedures:

This procedure was initiated from the gliding flight configuration (landing gear retracted, propeller stowed, flaps at zero degrees) at different altitudes in the cleared and certified start envelope. The

procedure was flown at 62 knots indicated airspeed to simulate a pilot attempting to hold best glide speed (57 knots indicated airspeed) and getting fast due to the distraction of running the engine start checklist. While performing this procedure, the pilot flew and perform all required actions while the test director read the following checklist

1. Propeller Dome - Extend and Lock
2. Cooling Air Doors - Open
3. Throttle - Open
4. Choke - As Required
5. Avionics Supply - Main Battery
6. Fuel Cock - Open
7. Main Electric Fuel Pump - On
8. Starter - On, for 5 sec
9. (Simulate) Ignition Switch - On
10. rpm/Charge Control Light - Check
11. Choke - Off
12. (Simulate) Ignition Switch- off
13. Repeat above procedure (steps 1-12)
14. Propeller Brake - Engage momentarily
15. Fuel Reserve - Check
16. Fuel Cocks - Both Open
17. Electrical Fuel Pump - On
18. Fuel Pump Circuit Breakers - Check in
19. Backup Fuel Pumps - On
20. Propeller Dome Lever - Push Down
21. (Simulate)Engine Bus Backup Switch-Select
22. Starter - On
23. Ignition Switch - On, after propeller deploys
24. Oil Pressure - check
25. Power - As Required to start climb

Steps 1-13 were the normal engine start checklist used by the USAFA. The remaining steps were from the Stemme engine malfunction checklist which was similar to, but more comprehensive than the Academy checklist for engine roughness. Total air temperature and fuel weight were noted before commencing the procedure. Altitude was noted and timing commenced upon initiation of the above checklist. Altitude was noted and timing terminated upon vertical velocity indicator (VVI) reversal as the aircraft climbed after the engine start. Data were considered valid if the airspeed varied by less than 5 knots and variometer indicated no more than 100 feet per minute lift or sink.

Corrections to observed altitude losses were performed for nonstandard day temperatures and airspeed changes during the procedure. Corrections for changes in aircraft gross weight were not necessary since the aircraft speed polar (Reference 1) showed negligible effects of gross weight below 70 knots (at 70 knots, sink rate varied from 150 to 160 feet per minute through the entire gross weight envelope of the aircraft). Error introduced by variations in altitude, since this was a gliding procedure, was sink rate being based on true airspeed rather than calibrated airspeed ($V_{sink}=V_{true} \sin\gamma$, where γ is the glider flight path angle). All testing was performed below 10,000 feet MSL and the TG-11 was a very high performance glider (γ between 1 and 2 degrees) so these errors were considered negligible. The correction for test day ambient air temperature difference from standard day was (Equation 5.28, Reference 4):

$$\Delta h = (T_a/T_s)\,\Delta h_c$$

Where:

Δh = Geopotential (actual) altitude change

Δh_c = Pressure altitude change

T_s = Standard day ambient air temperature

T_a = Test day ambient air temperature

The correction for airspeed changes was (Equation 9.11, Reference 5):

$$\frac{dE_s}{dt} = \frac{dh}{dt} + \frac{VdV}{gdt}$$

Where:

E_s = Energy (sum of kinetic and potential energy)

h = Geopotential altitude

V = True airspeed

g = Acceleration due to gravity

This equation was used to determine total energy change of the aircraft and was then solved for a constant true airspeed descent by setting the dV/dt term equal to zero.

Altitude Loss for Engine Start Results:

Eight out of the desired nine data points were collected Table D1, but the data were very scattered. The altitude losses varied from 420 to 850 feet and the times required to run the checklist varied from

1.9 to 3.2 minutes. It was desired that the 95 percent confidence interval for the mean be smaller than ±10 percent of the sample mean. The mean for all data points was 600 feet, but the 95 percent confidence interval using a Student's t distribution and our sample standard deviation of 162 feet was ±144 feet (24.2 percent of the sample mean). Due to the data scatter, the success criteria for this objective was not met.

The cause of the data scattering could possibly be attributed to the time during the procedure that the propeller was windmilling as well as the light wing loading of the aircraft which made it very susceptible to any amount of lift or sink. The aircraft drag increased significantly (as shown by increased descent rates) with the propeller out. This increased drag was not measured during the investigation. Considering these factors, additional testing would not be warranted. Although the data gathered during this investigation were more scattered than desired, the altitude losses were realistic. Adequate safety margins can be attained by using the worst case 2-sigma altitude loss from this investigation. This would yield an altitude loss of 950 feet. **The data gathered in this investigation should be used by the USAFA to determine local guidance for minimum gliding altitudes. (R9)**

This investigation did reveal some other noteworthy information. Test day pressure altitude, as shown in Table 9, was not a factor in the engine start process. The lack of a clear trend in altitude loss variations with respect to altitude showed that these differences were a result of data scatter and individual technique and not due to changes in pressure altitude. This was significant because the engine was equipped with an unheated, nonturbocharged carburetor. In spite of this fact, the engine started as quickly at altitude as it did on the ground. In fact, the engine started successfully every time it was attempted with switches properly configured.

Table 9
ALTITUDE LOSS FOR ENGINE START

Pressure Altitude (ft)	Average Altitude Loss (ft)	Time Required (min)	Average Sink Rate (ft/min)
9,600	568	2.1	270
6,500	744	2.5	300
4,100	419	2.1	200

The engine start switchology was important. With the propeller windmilling, it sounded like the motor was turning over and only the ignition switch needed to be thrown to start the engine. The tachometer showed that the motor was not turning and the starter needed to be engaged. Although this was explained in the aircraft documentation, it is worth emphasizing to new pilots because of the confusion that this could cause. **Possible engine start switchology errors should be emphasized in the TG-11 curriculum. (R10)**

CRUISE

Cruise Procedures:

The objective of cruise testing was to determine the fuel flow and specific range of the TG-11 at maximum gross weight with the propeller pitch and flaps set in the cruise position at 8,500 feet pressure altitude at standard day conditions. The data acquired at 8,500 feet were standardized to 7,500, 8,500, and 9,500 feet pressure altitudes. Due to the limited scope of the HAVE CHRYSALIS evaluations, the traditional speed-power flight test technique of determining fuel flows across a wide range of aircraft weight and Mach numbers was not conducted. Instead, fuel flow and specific range were measured at a single engine speed of 2,500 rpm near the aircraft's maximum gross weight. The specified conditions represent the midband cruise engine speed setting and TG-11 cross-country operating altitudes.

Testing was conducted within 2 percent of the aircraft's maximum gross weight of 1,874 pounds at 8,500 feet pressure altitude. Flight test data band and tolerances were in accordance with the USAF Test Pilot School's *Performance Phase Planning Guide* (Reference 6). Altitude and vertical airspeed tolerances were ±100 feet and ±100 feet per minute respectively. Airspeed tolerance was ±2 knots. An engine speed tolerance of ±50 rpm was also set by the test team. The aircraft was first stabilized at an engine speed of2,500 revolutions per minute with the propeller pitch in the cruise position. The air cooling scoop handle was placed in the first notched position and flap position was set at zero degrees. Five measurements of airspeed, fuel flow, ambient air temperature, and pressure altitude were taken at30 second intervals across a 2-minute period.

Data reduction formulas were obtained from the *Performance Flight Test Phase Textbook, Chapter 11, Cruise Performance Theory* (Reference 7) and are listed in Appendix E. All data were standardized to standard day 8,500 feet conditions. Averages of fuel flow and specific range were then calculated and analyzed for their statistical relevance using the Student's t distribution. Finally, the average standardized results were standardized to 7,500 and 9,500 feet standard day conditions.

Cruise Results:

The objective was met. Raw data and reduction calculations are presented in Appendix E. Results were consistent. The maximum range of fuel flow measurements differed only by 0.3 gallons per hour (7 percent). The maximum difference between calculated specific ranges was two nautical air miles per gallon (9 percent). Averaged results of fuel flow and specific range are presented in Table 10. The 95 percent confidence range (i.e., that the population averages lie within the specified sample range) was quite small and provided adequate values for cross-country planning operations.

Table 11 lists standardized values of fuel flow and specific range for the specified cruising altitudes. No flight manual cruise data were available for comparison at the test altitudes. **The HAVE CHRYSALIS cruise data should be used for the TG-11 aircraft cross-country training program. (R11)**

Table 10
TG-11 STANDARDIZED CRUISE DATA RESULTS AT 1,874 POUNDS GROSS WEIGHT AND 8,500 FEET STANDARD DAY CONDITIONS

Measurement	Number of Measurements	Average	Standard Deviation	95 Percent Confidence Range[1]
Fuel Flow (gal/hr)	9	4.3	0.14	±0.12
Specific Range (NAM/gal)	9	23	0.66	±0.54

Notes: 1. Propeller pitch in the cruise position at 2,500 rpm
2. Flaps set at zero degrees and engine cooling scoop handle in the first notched position
3. NAM/gal - Nautical air miles per gallon

[1]Confidence that the population mean lies within the specified range

Table 11
TG-11 STANDARD DAY 1,874 POUNDS GROSS WEIGHT CRUISE DATA

Pressure Altitude (ft)	Fuel Flow (gal/hr)	Specific Range (NAM/gal)[1]
7,500	4.5	22
8,500	4.3	23
9,500	4.1	24

Notes: 1. Flaps set at zero degrees and engine cooling scoop handle in the first notched position
2. NAM/gal - Nautical air miles per gallon

[1]Propeller pitch in the cruise position at 2,500 rpm

CONCLUSIONS AND RECOMMENDATIONS

Comparison of test data to that of the flight manual for takeoff distance and distance to 50 feet reveal greater distances than those predicted by the flight manual; with the exception of the takeoff distance at 3,280 feet. The distances to 50 feet were significantly longer than predicted. Calculated values that ensure a ninety percent confidence level that distances will be less than stated provide a safety margin for training activity. Considerable improvement in takeoff performance due to headwinds was evident by a 500-foot reduction in takeoff ground distance during 15-knot headwind conditions at the high density altitude test location.

1. The USAF Air Force Academy should use the HAVE CHRYSALIS test results for takeoff groundroll distance and for distance to 50 feet for their TG-11 aircraft training program (Page 5).

Two modifications should be made to the TG-11 based on pilot comments. The seat cushion sometimes moved when strapping it into the aircraft and could inhibit the stick.

2. The seat cushions should be held in place such that they cannot slide forward. (Page 6)

Due to the long flexible wings, very little angle of bank (less than 5 degrees) at low altitude could result in a wingtip contacting the ground.

3. The TG-11 should be modified with scrape tips on the underside of the wingtips. (Page 7)

Pilot comments were obtained during the initial checkout of the TPS pilots. Both pilots had little experience in light aircraft and gliders. Handling qualities which required increased pilot workload were noted.

4. The preliminary TG-11 Flight Manual should be updated to include the following advisories as Cautions, Notes, or Warnings:

a. The seat cushion can impair the ability of the pilot to make control stick inputs.

b. The pilot should expect the aircraft to yaw right, requiring considerable left rudder to counter, when the aircraft nose is rotated down during the takeoff roll.

c. Steep turns in the TG-11 require undivided pilot attention to maintain coordinated flight and controlled airspeeds.

d. Wingtip ground clearance requires constant pilot attention at low altitude. The aircraft should not be operated from runways where the wingtips overhang runway equipment (runway lights, runway signs, etc.)

e. The only way the pilot can be sure that the engine is operating after an attempted airstart is by observing the rpm gauge and charge light. (Page 7)

5. The USAFA TG-11 training syllabus should include the following areas :

a. Several turn coordination and steep turn drills repeated on multiple flights.

b. Demonstrate that the only way the pilot can be sure that the engine is operating after an attempted airstart is by observing the rpm gauge and charge light. (Page 7)

Obtaining climb data without excessive data scatter was difficult due to the low wing loading of the TG-11. The aircraft was very susceptible to atmospheric disturbances (lift and sink). The rate of climb on any day could be significantly greater or less than the average reported, depending on atmospheric conditions.

6. A warning should be placed in the TG-11 flight manual discussing the aircraft's degraded climb performance in the presence of descending air. (Page 8)

The TG-11 showed a strong tendency to overbank above 45 degrees of bank during the engine loss after takeoff tests. Only one 60-degree bank pattern was flown to desired airspeed tolerances; due to the limited elevator authority available to keep the nose from dropping. The increased difficulty flying this pattern outweighed the slight decrease in altitude lost during the maneuver.

7. A bank angle of 45 degrees should be used to turn downwind following an engine failure during the takeoff climbout. (Page 10)

The 95 percent confidence interval for the mean altitude loss to perform a 45-degree bank 180-degree turn to downwind was between 120 and 140 feet with a standard deviation of 20 feet. These altitude losses did not account for the altitude necessary for wingtip clearance or pilot reaction time. An initial investigation showed large altitude savings by braking the propeller to a stop while turning to downwind.

8. Further investigation of performance benefits from braking propeller and possible incorporation of guidance into engine failure on takeoff checklist should be accomplished. (Page 10)

The objective for altitude loss for engine start was not met. The light wing loading and increased drag of the windmilling propeller caused an undesirable amount of data scatter. Despite the scatter, altitude losses for engine starts were realistic and adequate safety margins could be attained by using the worst case 2 sigma altitude loss from this investigation. This would yield an altitude loss of 950 feet.

9. The data gathered in this investigation should be used by the USAFA to determine local guidance for minimum gliding altitudes. (Page 12)

The engine was found to be very reliable for airstarts (100 percent success rate with switches properly configured). However, the majority of engine noise heard in the cockpit actually comes from the propeller drivetrain which caused confusion in the engine start procedure if the propeller was windmilling.

10. Possible engine start switchology errors should be emphasized in the TG-11 curriculum. (Page 12)

Cruise measurements were consistent and provided enough statistical relevance to be suitable for cross-country operations in smooth air.

11. The HAVE CHRYSALIS cruise data should be used for the TG-11 aircraft cross-country training program. (Page 13)

REFERENCES

1. Flight Manual, Stemme S10-V, Stemme GmbH & Co., Strausberg, Germany, 16 February 1995.

2. Lush, Kenneth, *Standardization of Take-Off Performance Measurements for Airplanes*, AFFTC Technical Note R-12, Corrigendum, Air Force Flight Test Center, Edwards AFB, California 1982.

3. Herrington, R.M., et al., *Flight Test Engineering Handbook*, AFTR 6273, AFFTC, Edwards AFB, California, May 1951, revised January 1966.

4. Performance Flight Test Phase Textbook, Chapter 5, Pitot Statics and the Standard Atmosphere, USAF Test Pilot School, Edwards AFB, California, July 1995.

5. Performance Flight Test Phase Textbook, Chapter 9, Energy, USAF Test Pilot School, Edwards AFB, California, August 1991.

6. *Performance Phase Planning Guide,* USAF Test Pilot School, Edwards AFB, California, January, 1994.

7. Performance Flight Test Phase Textbook, Chapter 11, Cruise Performance Theory USAF Test Pilot School, Edwards AFB, California, September, 1993.

8. T-3A TOLD Evaluation (Have Zoom 95-17) Test Plan, USAF Test Pilot School, Edwards AFB, California, 23 March 1995.

9. TG-7 Motorglider TOLD Evaluation (Have Prop 89B-SO.2) Test Plan, USAF Test Pilot School, Edwards AFB, California, 15 March 1990.

This page intentionally left blank.

APPENDIX A

TAKEOFF TEST PROCEDURES

This page intentionally left blank.

GROUND STATION SETUP AND TEST TEAM DUTIES

GENERAL

Takeoff distance and distance to 50 feet AGL was measured similar to methods used in *T-3A Takeoff and Landing Data (HAVE ZOOM)* (Reference 8). Orange traffic cones were placed at 50-foot intervals along the runway to mark distances. The distances were measured using a standard walking wheel (cyclometer) with a 1-foot accuracy. Each ground station was equipped with a very high frequency (VHF) radio to maintain communication with the aircrew. A schematic of the test station layout is presented in Figure A1.

GROUND STATION 1

The purpose of Ground Station 1 was to measure time and distance to lift-off and record weather conditions. The station was positioned approximately 1,000 and 1,500 feet down the runways at Edwards AFB and Big Bear City Airport respectively. The observer positioned himself 150 feet from the edge of the runway to ensure adequate horizontal field of view. Weather parameters displayed in Table A1 were measured with calibrated handheld meters.

GROUND STATION 2

The purpose of Ground Station 2 was to measure the time and distance to 50 feet AGL. Distance was measured using a plexiglass theodolite (Figure A2) with 1-inch vertical grid lines. The function of the theodolite was to measure the distance to 50 feet using the principle of similar triangles. The theodolite was placed abeam the anticipated distance to 50 feet. Its datum line was 40.5 inches above the ground. An eyepiece placed 29 inches behind the grid was used to sight the aircraft passing 50 feet. The vertical centerline of the theodolite was aligned with a traffic cone. Vertical hash marks were placed along the appropriate grid line to note horizontal distance at the time of the 50-foot crossing. The theodolite was placed 451 feet from the runway centerline at the Edward's test site. This allowed the 50-foot point to coincide with the theodolite's 3-inch grid line and provided the viewer with 400 feet of horizontal field of view. Due to geographic constraints at Big Bear City Airport, the theodolite was positioned 301 feet from the runway centerline. This changed the applicable viewing grid line to 4.5 inches and shrunk the horizontal field of view to 200 feet. As a result, more frequent position adjustments were made at this test site. The test director orchestrated the test from this station.

FLIGHT CREW DUTIES

The TG-11 flight crew consisted of one USAF Test Pilot School instructor pilot and one test team member. Standardized takeoff procedures are listed in this Appendix. Takeoff speed tolerance was limited to ±3 knots to maximize result consistency. Recorded parameters are listed in Table A1. As a backup to Ground Station 1 measurements, wind velocity was recorded from tower and UNICOM reports. The crew also recorded engine speed and manifold pressure to ensure consistent settings and minimize data scatter. Prior to each takeoff test, crew and fuel weight were recorded. Gross weight prior to each takeoff was measured by noting fuel used since the previous takeoff. A breaks released announcement was made by the aircrew and used by the ground stations as the initiation of time to lift-off and time to 50 feet.

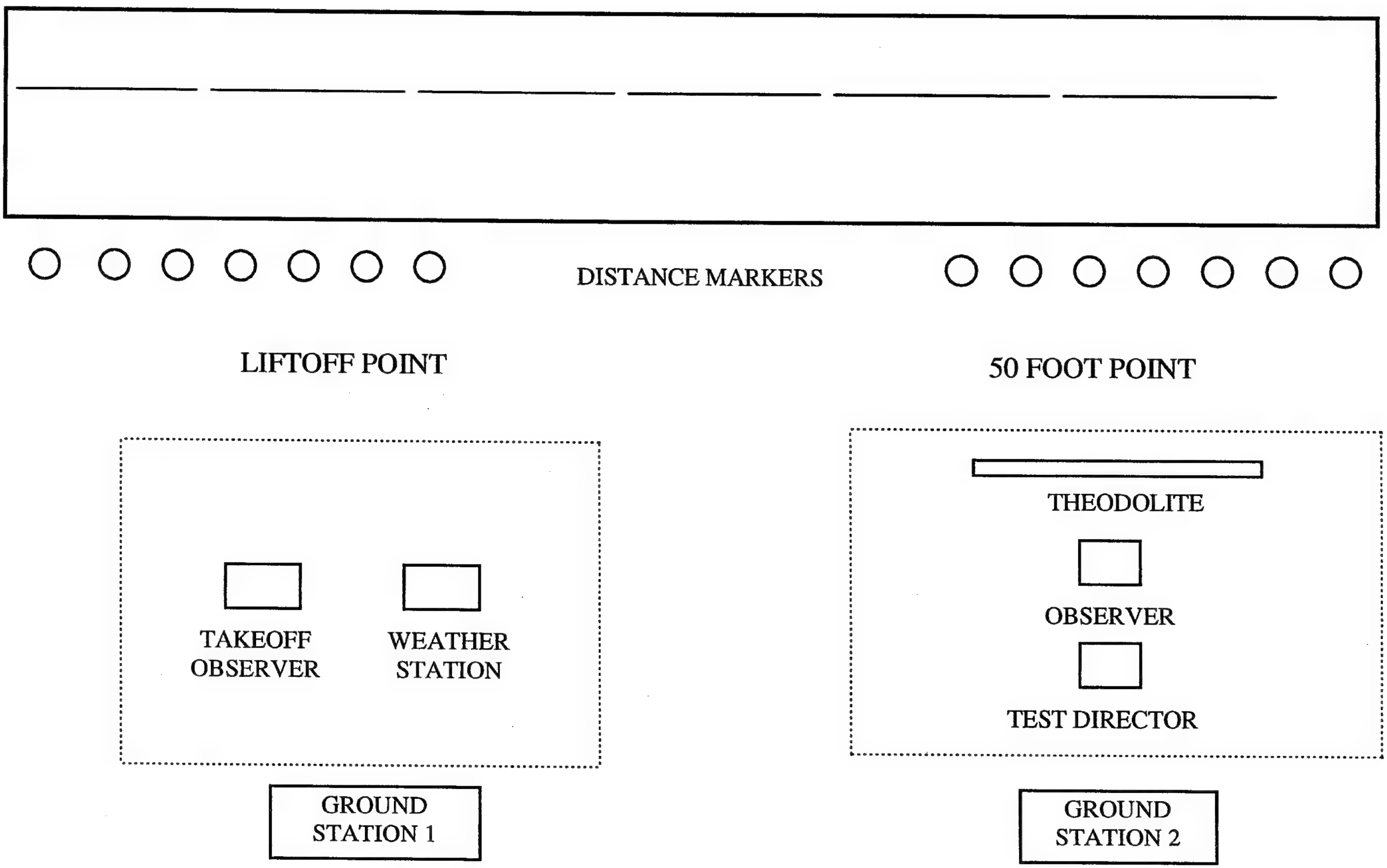


Figure A1 Takeoff Test Site Layout

Table A1
TAKEOFF TEST TEAM RESPONSIBILITIES

Team	Data Parameters	Location
Aircrew 1. TPS crewmembers	Fuel amount Ambient air temperature Tower/UNICOM winds Tail lift-off speed Rotate speed Climbout speed Manifold pressure Engine RPM	Aircraft
Ground Station 1 1. Weather recorder 2. Distance recorder	Lift-off point Elapsed time to lift-off Ambient air temperature Ambient air pressure Wind speed and direction	Opposite lift-off point (150 ft from runway)
Ground Station 2 1. Theodolite operator 2. Test director	Point to clear 50 ft Elapsed time to clear 50 ft	Opposite point to clear 50 ft

HAVE CHRYSALIS TAKEOFF PROCEDURE

1. Neutral Stick
2. Smoothly apply full throttle
3. Raise tailwheel at 35 KIAS (smooth forward stick)
4. Stick neutral
5. Lift-off at 46 KIAS (smooth aft stick) to 10 feet AGL
6. Accelerate horizontally to 56 KIAS (best climb angle speed)
7. Climbout at 56 KIAS (smooth aft stick)
8. Raise gear at 100 feet above ground level

SPECIFIC TAKEOFF DATA REDUCTION PROCEDURES

Standardization of Takeoff Ground Roll:

Note: Formulas are from Lush and Herrington (Reference 2 and 3).

Data reduction corrected observed takeoff roll for winds. An empirical relationship that works well for steady winds within 10 percent of the takeoff speed is:

$$S_{gw} = S_{gt}\ (1 + W/V_t)^{1.85}$$

Where:

S_{gw} Takeoff distance corrected for wind

S_{gt} Test day ground run

W Runway wind component (+headwind, -tailwind)

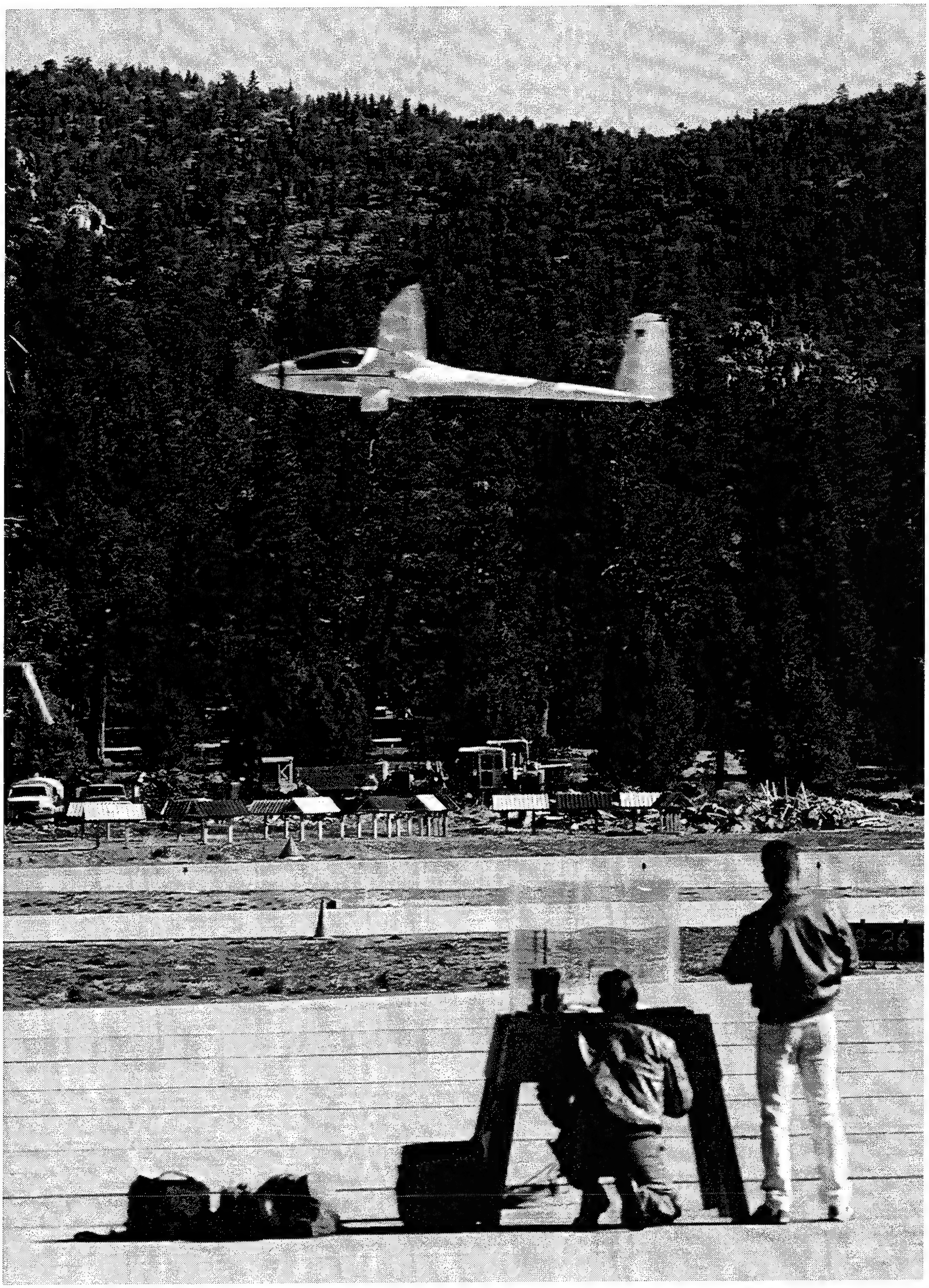


Figure A2 Theodolite Setup

V_t = True airspeed at lift-off

Correction for runway slope was then computed. The formula used is:

$$S_{gs} = S_{gw} / (1 + (2g\, S_{gw}\, \mathrm{SIN}\, \theta / V_t^{\,2})$$

Where:

S_{gs} = Takeoff distance corrected to level runway

S_{gw} = Takeoff distance corrected for winds

g = Acceleration of gravity (32.2 ft/sec^2)

Runway slope, measured from horizontal (+ uphill, - downhill)

An uphill slope of 0.029 radian was used for Edwards AFB calculations. The runway at Big Bear City Airport was virtually level.

Weight and density altitude corrections are then computed. Both ground run and air portion formulas are valid for light aircraft with fixed pitch propellers at full throttle settings. Exponents were corrected by the May 1982 Corrigendum to Lush's technical note (Reference 2). The empirical formula is:

$$S_{gstd} = S_{gs}\ (W_s / W_t)^{2.4}\ (\sigma_s / \sigma_t)^{-2.4}\ (T_s / T_t)^{-0.7}$$

Where:

S_{gstd} = Standard, zero slope, zero wind ground run distance

S_{gs} = Takeoff distance corrected to level runway

W_s = Weight at standard conditions

W_t = Weight at test conditions

σ_s = Density ratio at standard altitude

σ_t = Density ratio at test conditions

T_s = Absolute ambient air temperature at standard altitude

T_t = Absolute ambient air temperature at test conditions.

Standardization for Air Distance to 50 Feet:

Wind correction accounted for distance over the ground the aircraft would have flown without the presence of wind:

$$S_{awind} = S_{atest} + (W * t_{50})$$

Where:

S_{awind} = Air distance corrected for wind

S_{atest} = Test day air distance

W = Test day runway wind component (+ headwind, - tailwind)

t_{50} = Time to travel test day air distance

Weight and density altitude corrections for the air portion of takeoff were then made similar to ground run:

$$S_{astd} = S_{awind}\ (W_s / W_t)^{2.2}\ (\sigma_s / \sigma_t)^{-2.2}\ (T_s / T_t)^{-0.9}$$

Where:

S_{astd} = Standard, zero wind air distance

S_{awind} = Air distance corrected for wind

W_s = Weight at standard conditions

W_t = Weight at test conditions

σ_s = Density ratio at standard altitude

σ_t = Density ratio at test conditions

T_s = Absolute ambient air temperature at standard altitude

T_t = Absolute ambient air temperature at test conditions

This page intentionally left blank.

APPENDIX B

RAW TAKEOFF DATA AND REDUCTION

This page intentionally left blank.

RAW TAKEOFF DATA AND REDUCTION

Tables B1 and B2 contain the raw takeoff data and data reduction for both Edwards AFB and Big Bear City Airport, California test locations taken on 4, 8, and 23 April 1996. The spreadsheets utilized the formulas listed in Appendix A. Calculations were rounded to the nearest significant digit consistent with instrument accuracy.

Table B1

TG-11 TAKEOFF DATA AND STANDARDIZATION TO 3,280 FEET STANDARD DAY CONDITIONS

TEST DATE: 4 AND 8 APR 96

LOCATION: EDWARDS AFB, CALIFORNIA

Takeoff	Date	Sortie Number	South Base Runway	Wind Direction (deg)	Total Wind Speed (kt)	Ambient Air Temperature (deg F)	Ambient Air Temperature (deg R)	Pressure Altitude (ft)	Pressure Ratio	Temperature Ratio	Density Ratio	Equivalent Takeoff Speed (kt)
1	4 Apr 96	1	240	200	2	62	522	2,009	0.9295	1.0064	0.9236	45
2	4 Apr 96	1	240	200	2	62	522	2,009	0.9295	1.0064	0.9236	45
3	4 Apr 96	1	240	200	0	62	522	2,009	0.9295	1.0064	0.9236	45
4	8 Apr 96	2	240	190	1	53	513	2,145	0.9249	0.9890	0.9352	46
5	8 Apr 96	2	240	190	0	64	524	2,143	0.9249	1.0102	0.9156	46
6	8 Apr 96	2	240	190	2	57	517	2,140	0.9250	0.9967	0.9281	45
7	8 Apr 96	2	240	190	2	57	517	2,140	0.9250	0.9967	0.9281	45
8	8 Apr 96	2	240	190	2	58	518	2,138	0.9251	0.9987	0.9264	45
9	8 Apr 96	2	240	190	2	60	520	2,137	0.9252	1.0025	0.9228	45
10	8 Apr 96	2	240	190	3	59	519	2,132	0.9253	1.0006	0.9248	45
11	8 Apr 96	2	240	190	4	60	520	2,134	0.9253	1.0025	0.9229	45
12	8 Apr 96	2	240	180	4	61	521	2,133	0.9253	1.0044	0.9212	46
13	8 Apr 96	2	240	180	5	65	525	2,132	0.9253	1.0121	0.9142	45
14	8 Apr 96	2	240	180	5	67	527	2,127	0.9255	1.0160	0.9109	45

Table B1 (Continued)
TG-11 TAKEOFF DATA AND STANDARDIZATION TO 3,280 FEET STANDARD DAY CONDITIONS
TEST DATE: 4 AND 8 APR 96
LOCATION: EDWARDS AFB, CALIFORNIA

Takeoff	True Takeoff Speed (kt)	Head Wind (kt)	Ground Distance (ft)	Ground Time (sec)	Wind Corrected Ground Distance (ft)	Runway Slope (rad)	Slope Corrected Ground Distance (ft)	Test Weight (lb)	Ground Weight Factor	Ground Density Factor	Ground Temperature Factor
1	47	2	1100	26	1,170	0.029	1,163	1,885	0.9861	1.0432	1.0206
2	47	2	1225	25	1,303	0.029	1,294	1,882	0.9898	1.0432	1.0206
3	47	0	1200	25	1,200	0.029	1,193	1,880	0.9924	1.0432	1.0206
4	48	1	900	22	923	0.029	919	1,927	0.9353	1.0747	1.0083
5	48	0	900	21	900	0.029	896	1,925	0.9376	1.0215	1.0234
6	47	1	900	23	948	0.029	943	1,923	0.9399	1.0553	1.0138
7	47	1	950	24	1,000	0.029	995	1,921	0.9423	1.0553	1.0138
8	47	1	1000	26	1,053	0.029	1,047	1,919	0.9446	1.0506	1.0151
9	47	1	1000	26	1,053	0.029	1,047	1,918	0.9458	1.0410	1.0179
10	47	2	1050	25	1,135	0.029	1,128	1,925	0.9376	1.0463	1.0165
11	47	3	1000	23	1,110	0.029	1,104	1,922	0.9411	1.0413	1.0179
12	48	2	1050	24	1,136	0.029	1,130	1,921	0.9423	1.0366	1.0193
13	47	3	1050	24	1,162	0.029	1,155	1,918	0.9458	1.0179	1.0247
14	47	3	1000	23	1,106	0.029	1,100	1,915	0.9494	1.0091	1.0275

Table B1 (Concluded)
TG-11 TAKEOFF DATA AND STANDARDIZATION TO 3,280 FEET STANDARD DAY CONDITIONS
TEST DATE: 4 AND 8 APR 96
LOCATION: EDWARDS AFB, CALIFORNIA

Takeoff	3,280 Feet Standard Ground Distance (ft)	Distance to 50 Feet (ft)	Time to 50 Feet (sec)	Air Distance (ft)	Air Weight Factor	Air Density Factor	Air Temperature Factor	Wind Corrected Air Distance (ft)	3,280 Feet Standard Air Distance (ft)	Total 3,280 Feet Standard Distance (ft)
1	1,221	2,575	39	1,475	0.9872	1.0395	1.0266	1,509	1,589	2,810
2	1,364	2,600	39	1,375	0.9907	1.0395	1.0266	1,411	1,492	2,856
3	1,260	2,650	40	1,450	0.9930	1.0395	1.0266	1,450	1,537	2,797
4	931	2,450	37	1,550	0.9405	1.0683	1.0106	1,566	1,590	2,521
5	878	2,450	37	1,550	0.9426	1.0197	1.0301	1,550	1,535	2,413
6	948	2,450	37	1,550	0.9448	1.0506	1.0177	1,580	1,597	2,545
7	1,003	2,475	36	1,525	0.9470	1.0506	1.0177	1,551	1,570	2,574
8	1,055	2,500	36	1,500	0.9491	1.0463	1.0195	1,522	1,541	2,596
9	1,049	2,500	37	1,500	0.9502	1.0376	1.0230	1,524	1,537	2,586
10	1,125	2,475	38	1,425	0.9426	1.0424	1.0213	1,467	1,472	2,598
11	1,101	2,450	36	1,450	0.9459	1.0378	1.0230	1,506	1,513	2,614
12	1,125	2,450	38	1,400	0.9470	1.0335	1.0248	1,447	1,452	2,576
13	1,139	2,500	37	1,450	0.9502	1.0164	1.0319	1,505	1,500	2,639
14	1,082	2,450	37	1,450	0.9535	1.0083	1.0354	1,509	1,502	2,585

Table B2
TG-11 TAKEOFF DATA AND STANDARDIZATION TO 6,560 FEET STANDARD DAY CONDITIONS
TEST DATE: 23 APR 96
LOCATION: BIG BEAR CITY AIRPORT, CALIFORNIA

Takeoff	Date	Sortie Number	Runway	Wind Direction (deg)	Total Wind Speed (kt)	Ambient Air Temperature (deg F)	Ambient Air Temperature (deg R)	Pressure Altitude (ft)	Pressure Ratio	Temperature Ratio	Density Ratio	Equivalent Takeoff Speed (kt)
1	23 Apr 96	1	260	300	4	50	510	6,340	0.7912	0.9832	0.8047	45
2	23 Apr 96	1	260	260	3	53	513	6,340	0.7912	0.9890	0.8000	45
3	23 Apr 96	1	260	300	7	55	515	6,300	0.7924	0.9929	0.7980	46
4	23 Apr 96	1	260	270	6	55	515	6,300	0.7924	0.9929	0.7980	46
5	23 Apr 96	1	260	270	4	59	519	6,300	0.7924	1.0006	0.7919	46
6	23 Apr 96	1	260	280	3	59	519	6,300	0.7924	1.0006	0.7919	46
7	23 Apr 96	1	260	270	3	60	520	6,320	0.7918	1.0025	0.7898	46
8	23 Apr 96	1	260	290	2	66	526	6,320	0.7918	1.0141	0.7808	46
9	23 Apr 96	1	260	280	5	68	528	6,320	0.7918	1.0179	0.7778	46
10	23 Apr 96	1	260	260	6	68	528	6,300	0.7924	1.0179	0.7784	46
11	23 Apr 96	1	260	280	4	68	528	6,300	0.7924	1.0179	0.7784	46
12	23 Apr 96	1	260	270	5	68	528	6,300	0.7924	1.0179	0.7784	46
13	23 Apr 96	1	260	270	5	68	528	6,320	0.7918	1.0179	0.7778	48
14	23 Apr 96	1	260	270	6	69	529	6,300	0.7924	1.0199	0.7769	45

Table B2 (Continued)
TG-11 TAKEOFF DATA AND STANDARDIZATION TO 6,560 FEET STANDARD DAY CONDITIONS
TEST DATE: 23 APR 96
LOCATION: BIG BEAR CITY AIRPORT, CALIFORNIA

Takeoff	True Takeoff Speed (kt)	Head Wind (kt)	Ground Distance (ft)	Ground Time (sec)	Wind Corrected Ground Distance (ft)	Runway Slope (rad)	Slope Corrected Ground Distance (ft)	Test Weight (lb)	Ground Weight Factor	Ground Density Factor	Ground Temperature Factor
1	50	3	1,625	31	1,826	0	1,826	1,892	0.9773	0.9509	1.0207
2	50	3	1,650	32	1,849	0	1,849	1,887	0.9835	0.9376	1.0249
3	51	5	1,475	31	1,808	0	1,808	1,883	0.9886	0.9323	1.0277
4	51	6	1,500	31	1,879	0	1,879	1,879	0.9936	0.9323	1.0277
5	52	4	1,625	33	1,882	0	1,882	1,875	0.9987	0.9152	1.0333
6	52	3	1,575	32	1,747	0	1,747	1,872	1.0026	0.9152	1.0333
7	52	3	1,575	32	1,756	0	1,756	1,868	1.0077	0.9093	1.0347
8	52	2	1,725	35	1,836	0	1,836	1,887	0.9835	0.8846	1.0430
9	52	5	1,600	33	1,905	0	1,905	1,883	0.9886	0.8766	1.0458
10	52	6	1,550	32	1,943	0	1,943	1,879	0.9936	0.8782	1.0458
11	52	4	1,750	35	2,010	0	2,010	1,875	0.9987	0.8782	1.0458
12	52	5	1,650	34	1,982	0	1,982	1,871	1.0039	0.8782	1.0458
13	54	5	1,775	36	2,115	0	2,115	1,867	1.0090	0.8766	1.0458
14	51	6	1,675	34	2,103	0	2,103	1,860	1.0182	0.8742	1.0472

Table B2 (Concluded)
TG-11 TAKEOFF DATA AND STANDARDIZATION TO 6,560 FEET STANDARD DAY CONDITIONS
TEST DATE: 23 APR 96
LOCATION: BIG BEAR CITY AIRPORT, CALIFORNIA

Takeoff	6,560 Feet Standard Ground Distance (ft)	Distance to 50 Feet (ft)	Time to 50 Feet (sec)	Air Distance (ft)	Air Weight Factor	Air Density Factor	Air Temperature Factor	Wind Corrected Air Distance (ft)	6,560 Feet Standard Air Distance (ft)	Total 6,560 Feet Standard Distance (ft)
1	1,732	3,025	48	1,400	0.9792	0.9549	1.0267	1,488	1,428	3,161
2	1,747	3,000	48	1,350	0.9849	0.9427	1.0321	1,431	1,371	3,119
3	1,712	2,950	47	1,475	0.9895	0.9378	1.0357	1,620	1,557	3,269
4	1,789	3,200	50	1,700	0.9942	0.9378	1.0357	1,890	1,825	3,614
5	1,777	3,200	50	1,575	0.9988	0.9219	1.0430	1,688	1,621	3,398
6	1,656	3,225	51	1,650	1.0024	0.9219	1.0430	1,740	1,677	3,334
7	1,665	3,250	49	1,675	1.0071	0.9165	1.0448	1,760	1,697	3,362
8	1,666	3,275	50	1,550	0.9849	0.8937	1.0556	1,594	1,481	3,147
9	1,727	3,275	50	1,675	0.9895	0.8862	1.0592	1,810	1,681	3,408
10	1,773	3,275	49	1,725	0.9942	0.8877	1.0592	1,897	1,773	3,547
11	1,843	3,325	50	1,575	0.9988	0.8877	1.0592	1,670	1,569	3,412
12	1,828	3,400	52	1,750	1.0035	0.8877	1.0592	1,900	1,793	3,620
13	1,957	3,400	50	1,625	1.0083	0.8862	1.0592	1,741	1,648	3,605
14	1,960	3,150	49	1,475	1.0166	0.8840	1.0610	1,625	1,549	3,509

This page intentionally left blank.

APPENDIX C

SAWTOOTH CLIMB DATA AND REDUCTION

This page intentionally left blank.

DATA REDUCTION ALGORITHM/PROCESS

The airspeed indicator and altimeter were calibrated before testing. The airspeed indicator had zero instrument error and actual readings were used as V_c. It was assumed that the Pitot-static position error corrections were zero. Pressure altitudes (H_c) for target altitudes are listed in Table C1.

Table C1
ALTIMETER INSTRUMENT CORRECTIONS

Altimeter Reading (ft)	Actual Altitude (ft)	Correction to be Added (ft)
3,110	3,105	-5
3,220	3,210	-10
3,330	3,320	-10
3,440	3,425	-15
6,400	6,380	-20
6,500	6,480	-20
6,600	6,580	-20
6,700	6,680	-20
9,680	9,660	-20
9,760	9,740	-20
9,840	9,820	-20
9,920	9,900	-20

True velocity (V_T) was calculated and then the acceleration correction was applied: (V_T measured at nominal test altitude, $dV_T = V_{T\,peak\,alt} - V_{T\,base\,alt}$).

$$V_c = V_e$$

$$\theta = T_a/T_s$$

$$\delta = (1 - 6.87558*10^{-6}(H_c))^{5.2559}$$

$$\sigma = \delta/\theta$$

$$V_T = V_e/\text{sqrt}(\sigma)$$

$$ROC_{std\,day} = ROC_{test}(T_a/T_S)$$

Where:

V_c = Calibrated Airspeed

V_e = Equivalent Airspeed

θ = Temperature Ratio

δ = Pressure Ratio

σ = Density Ratio

V_T = True Airspeed

$$ROC_{ACC} = ROC_{std\,day}[1+(V_T/g)(dV_T/dH_c)]$$

The rate of climb was then corrected for weight:

$$\Delta ROC_W = ROC_{ACC}\,[(W_{test} - W_S)/\,W_{test}\,]$$

All data were standardized to the maximum gross weight of 1,874 pounds. The standardized rate of climb was a summation of the two corrections.

$$ROC_S = ROC_{ACC} + \Delta ROC_W$$

This reduction process was used in reducing all altitude increments.

TEST RESULTS

Figures C1 through C9 show the best rate of climb data from the first three flights at each target altitude. The best climb speed was determined from these plots to be 62 knots. Tables C2 to C4 and Figure C10 present the flight test data for the best rate of climb at the three target altitudes at 3,000 RPM. Tables C5 and C6, and Figure C11 present flight test data for best rate of climb at target altitudes of 3,280 and 6,560 feet at full throttle. Figure C12 presents the flight test and flight manual best rates of climb at the target altitudes.

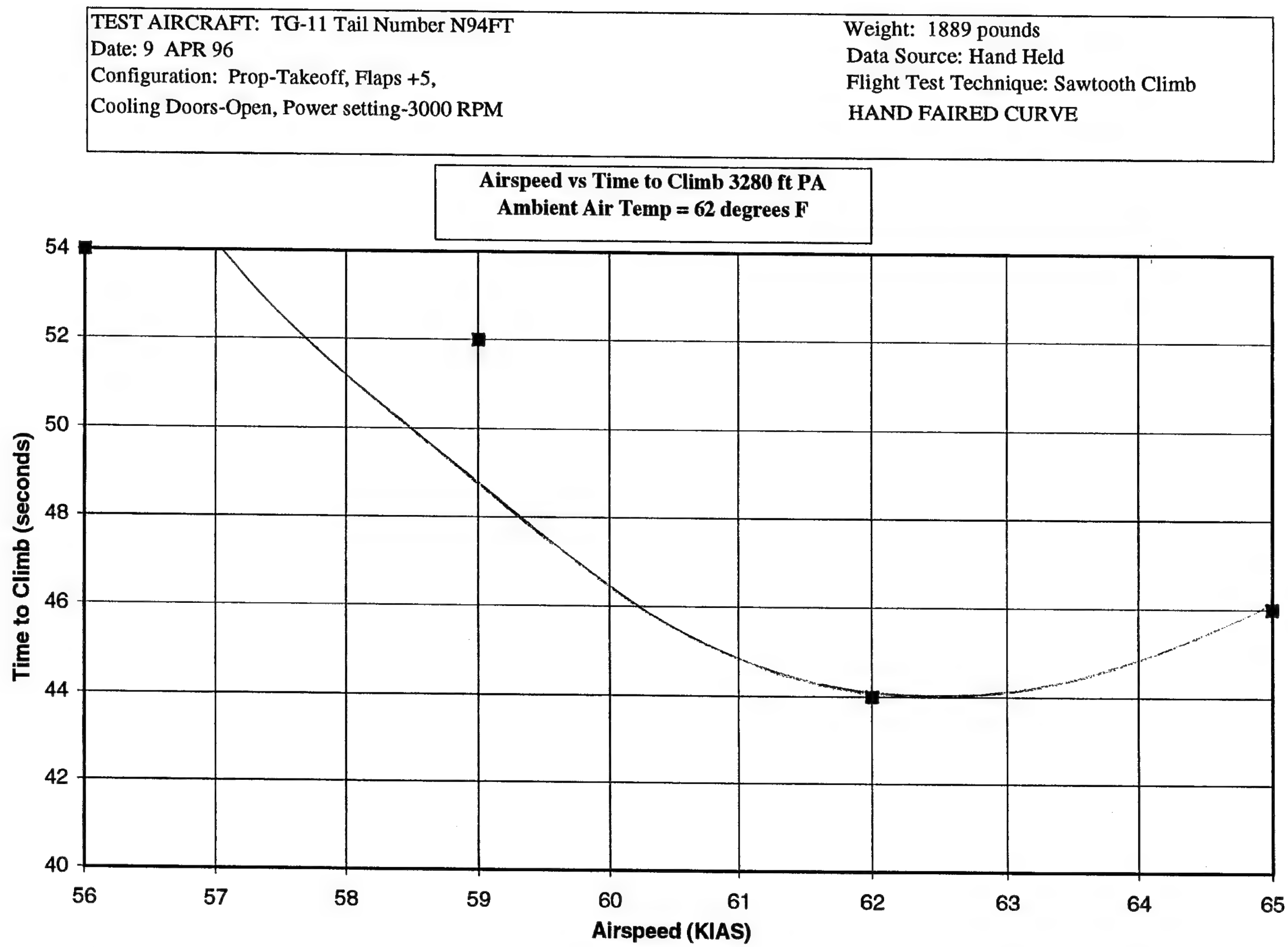


Figure C1 Best Speed to Climb 3280 ft PA, Flight 1

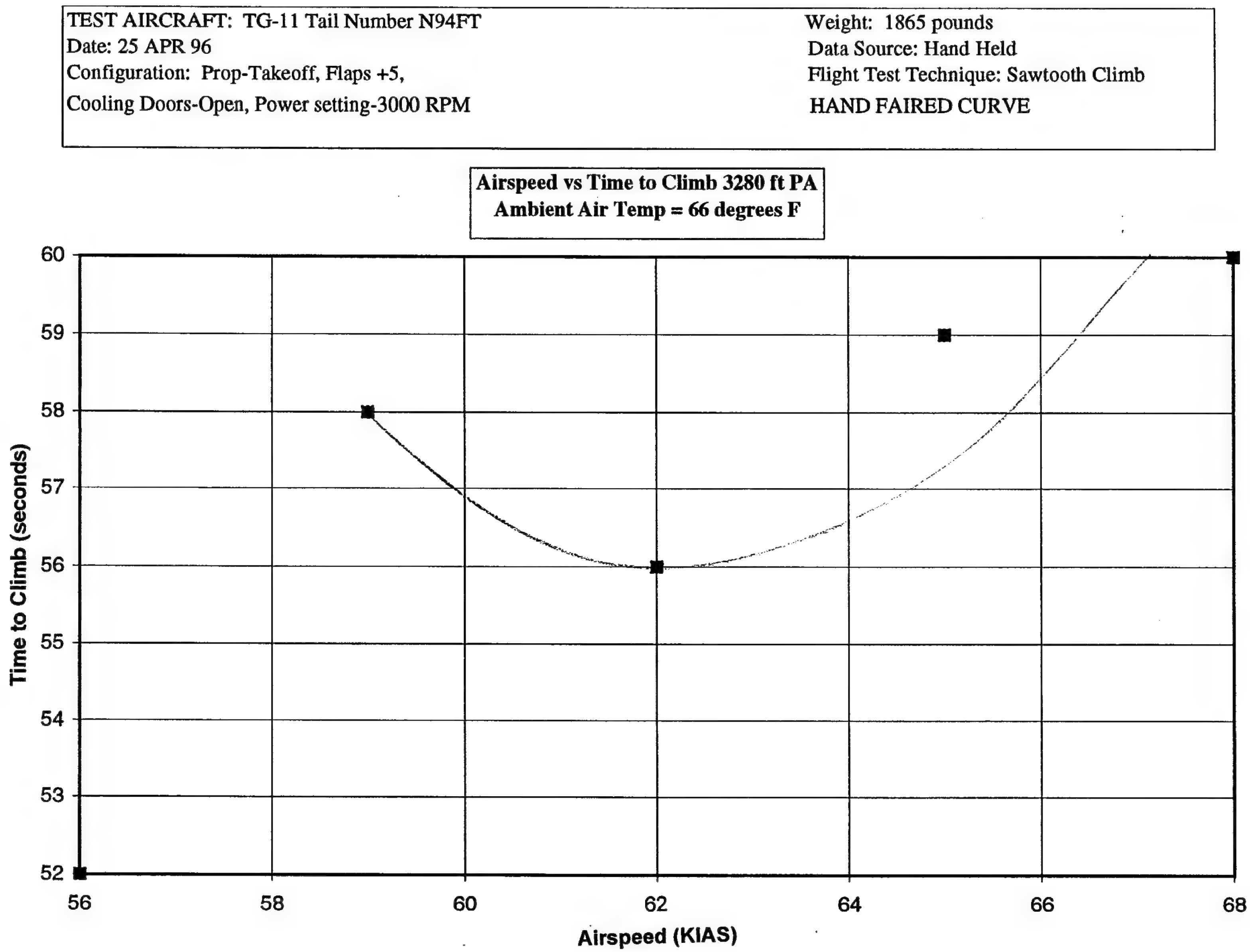


Figure C2 Best Speed to Climb, 3280 ft PA, Flight 2

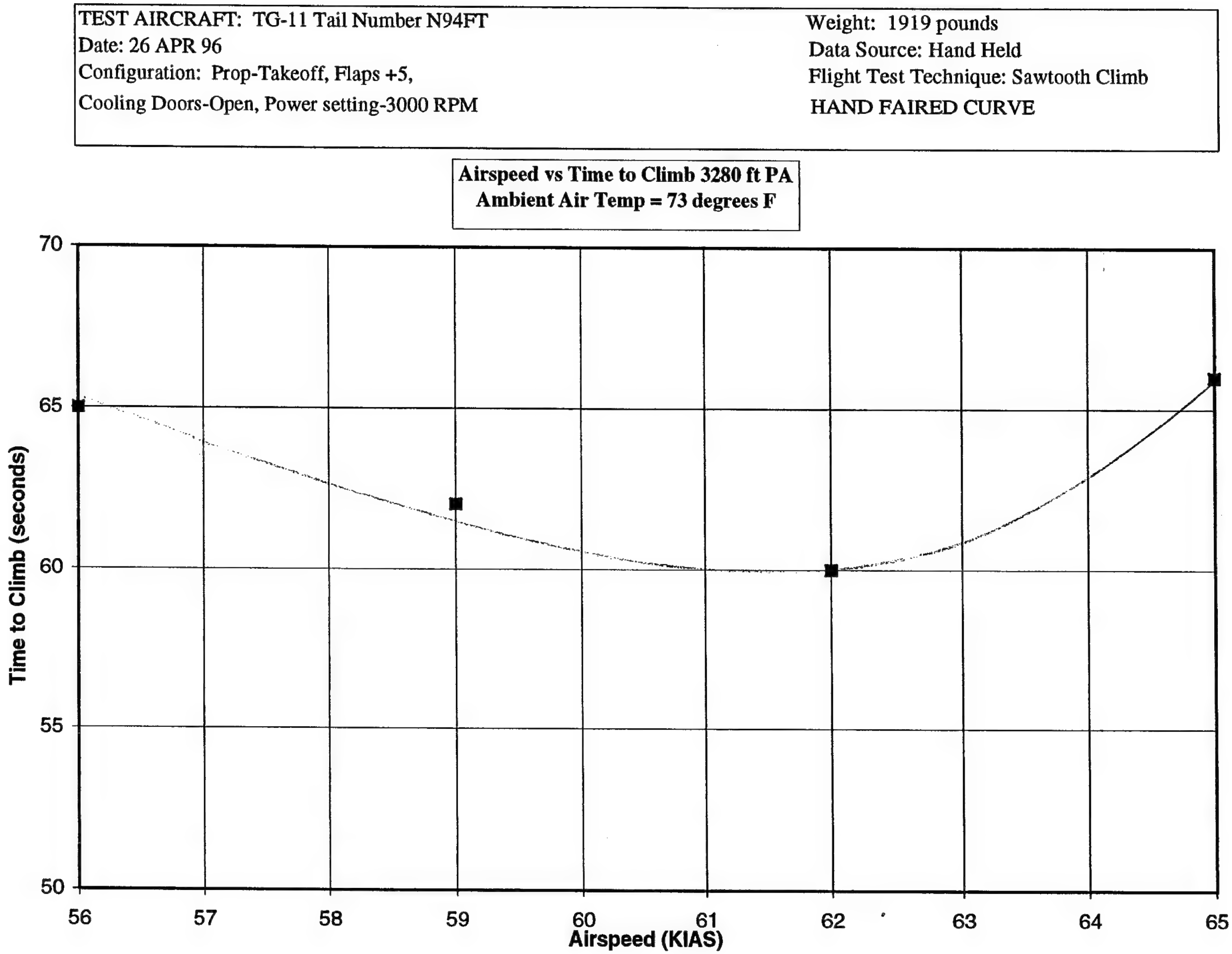


Figure C3 Best Speed to Climb, 3280 ft PA, Flight 3

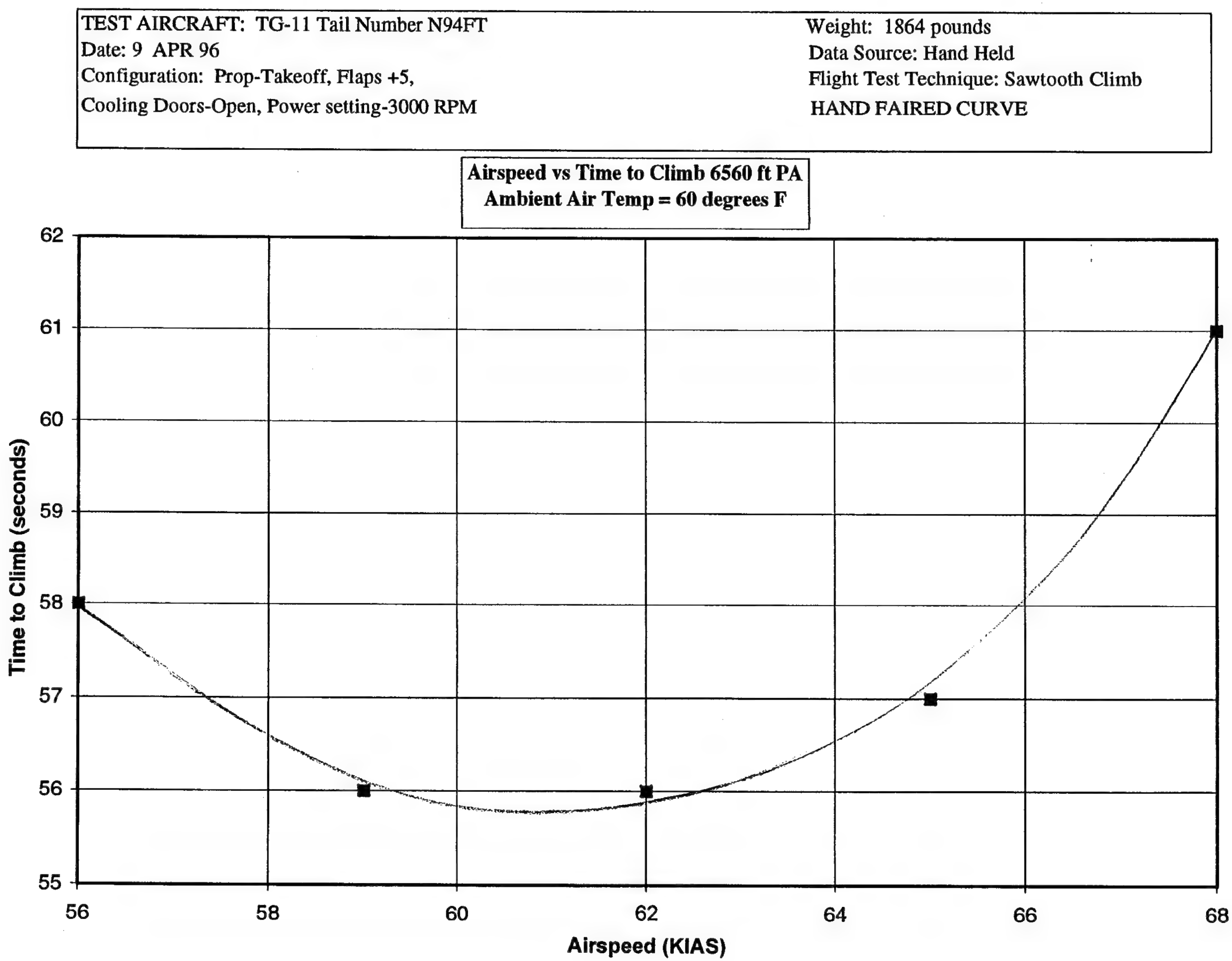


Figure C4 Best Speed to Climb, 6560 ft PA, Flight 1

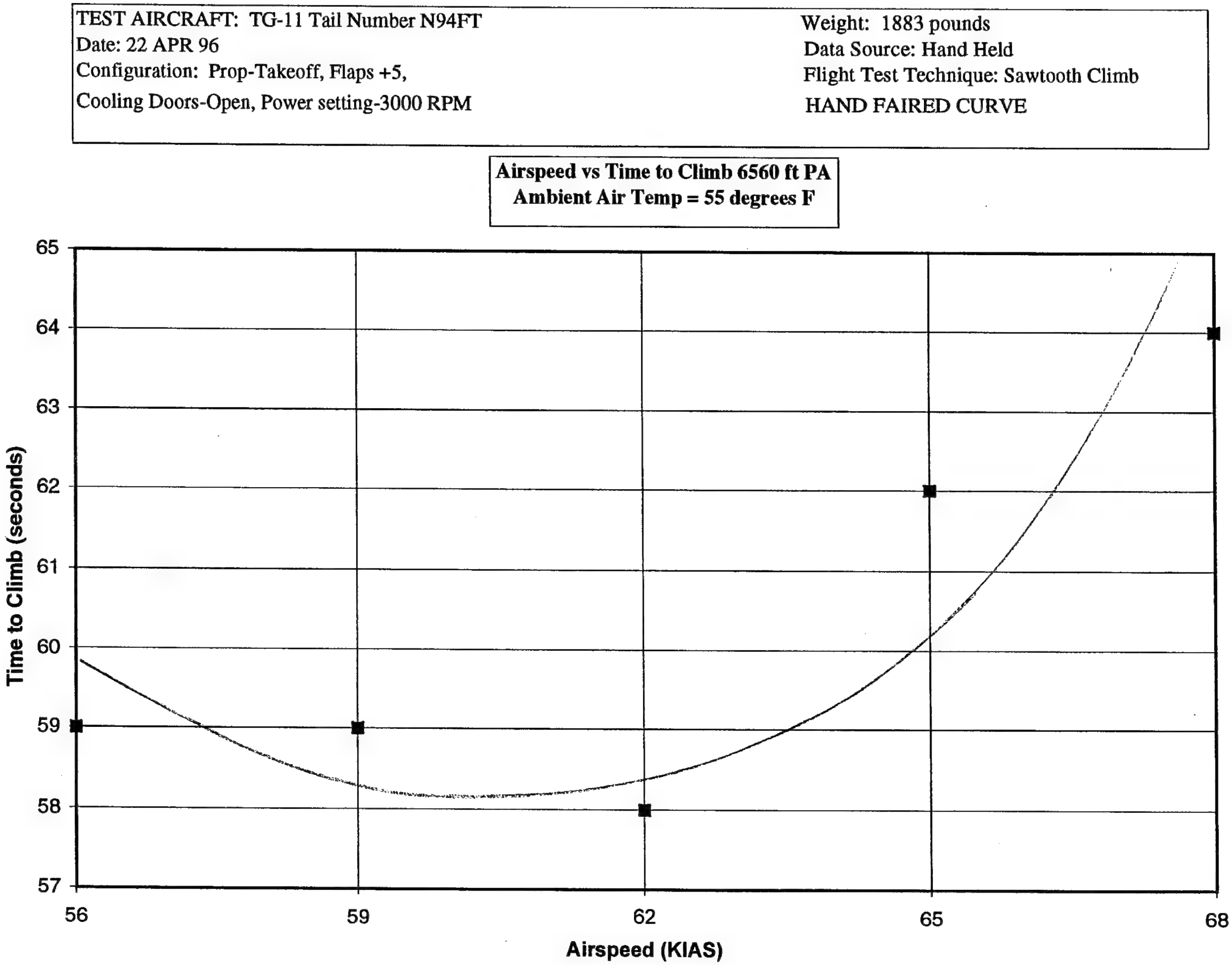


Figure C5 Best Speed to Climb, 6560 ft PA, Flight 2

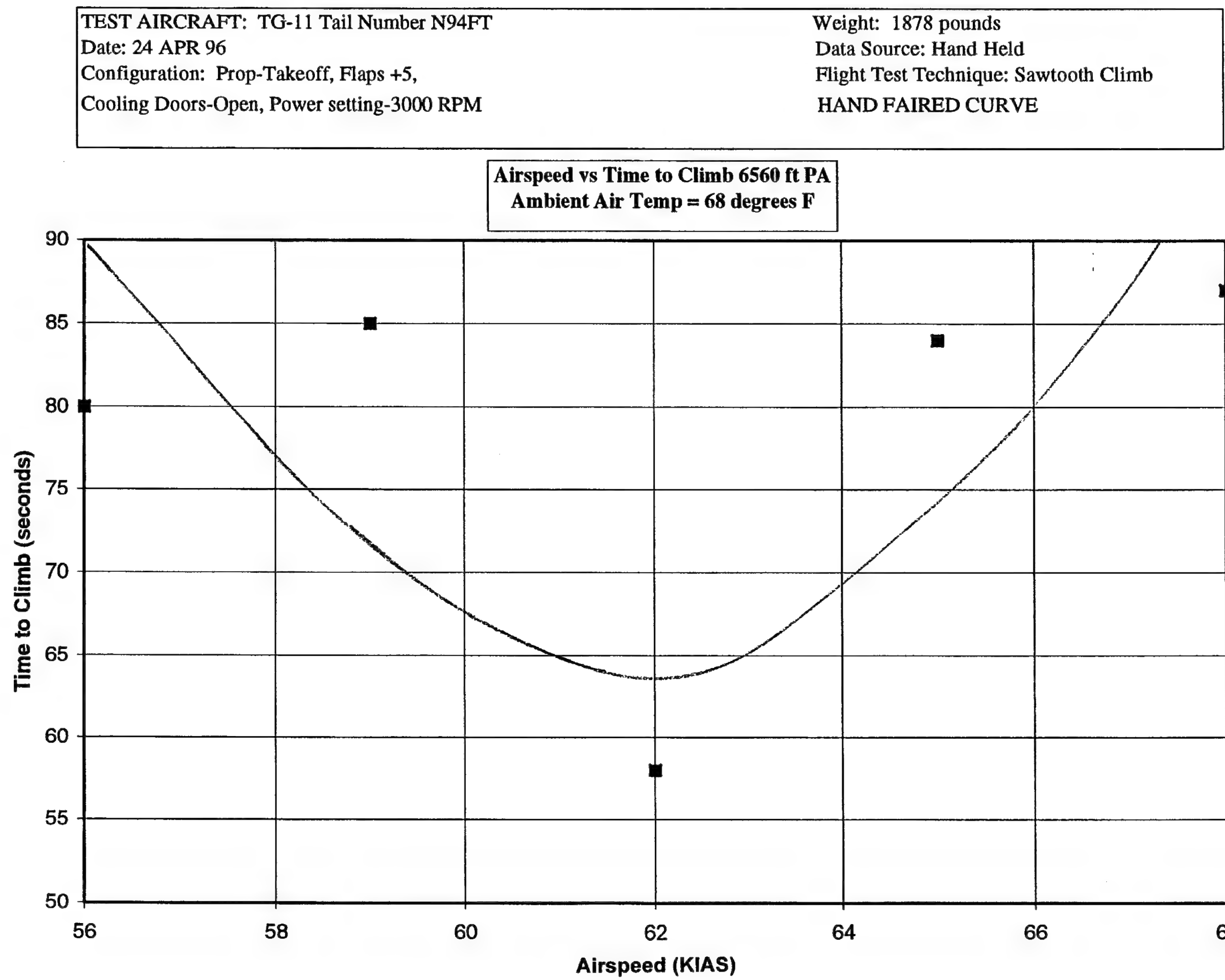


Figure C6 Best speed to Climb, 6560 ft PA, Flight 3

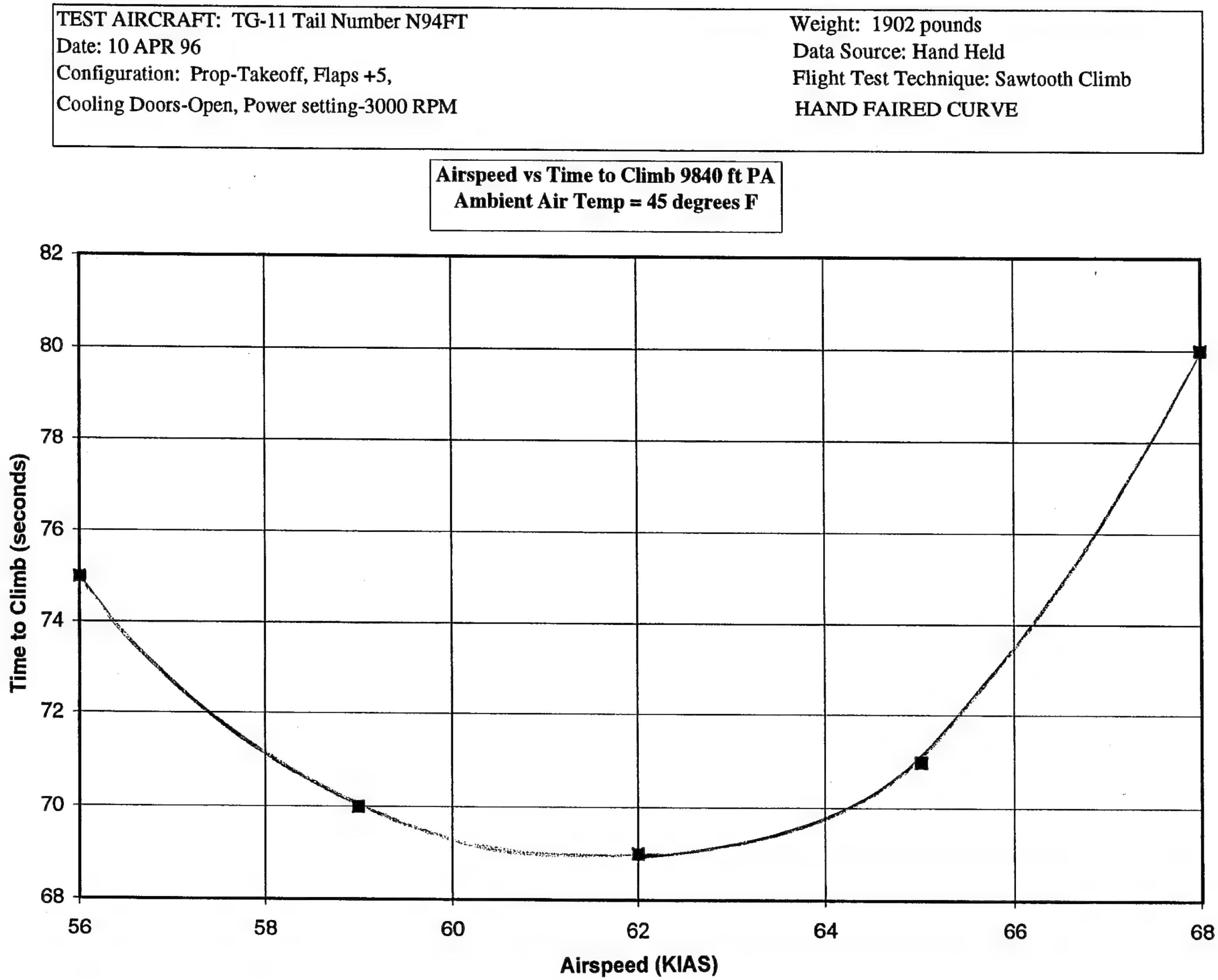


Figure C7 Best Speed to Climb, 9840 ft PA, Flight 1

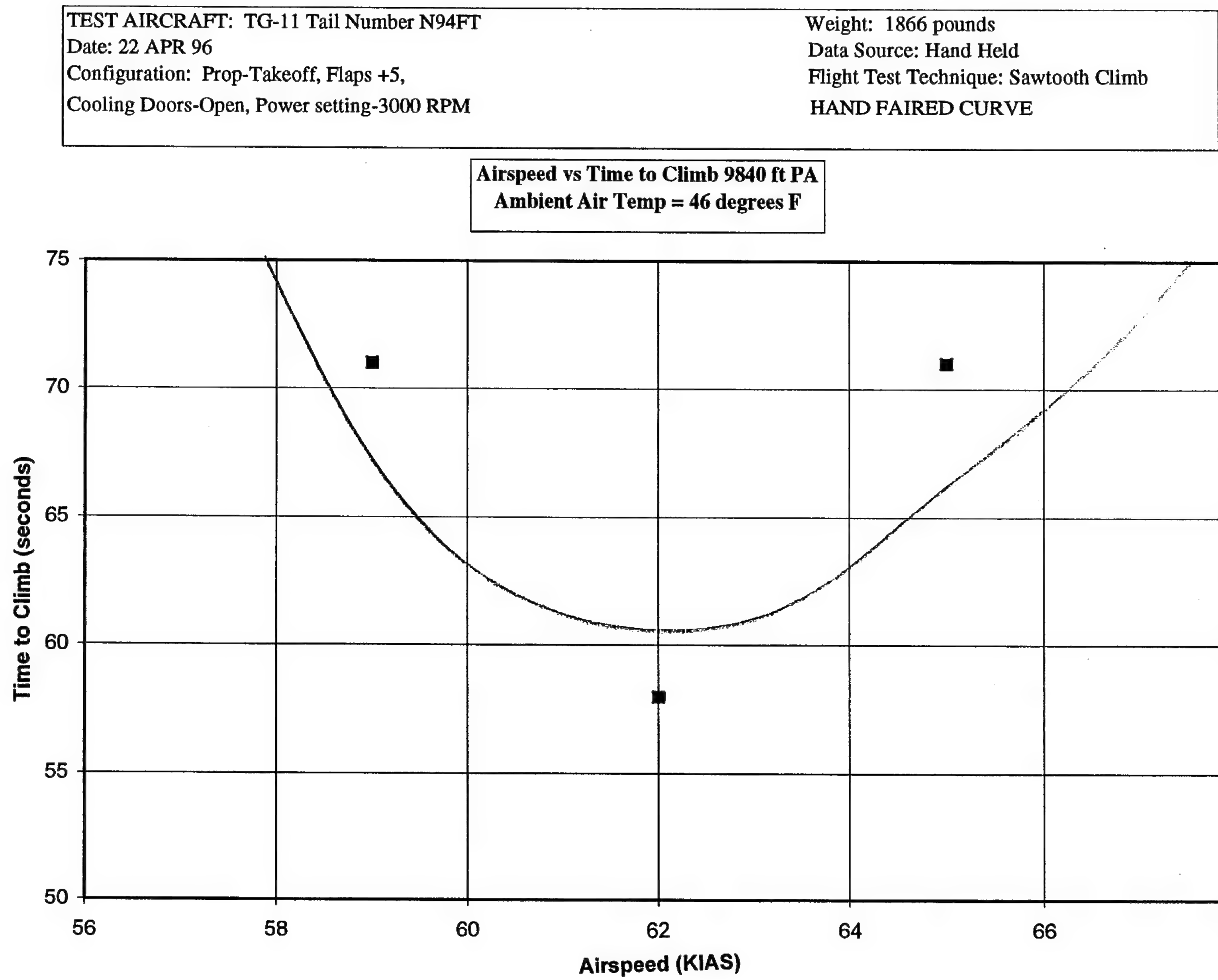


Figure C8 Best Speed to Climb, 9840 ft PA, Flight 2

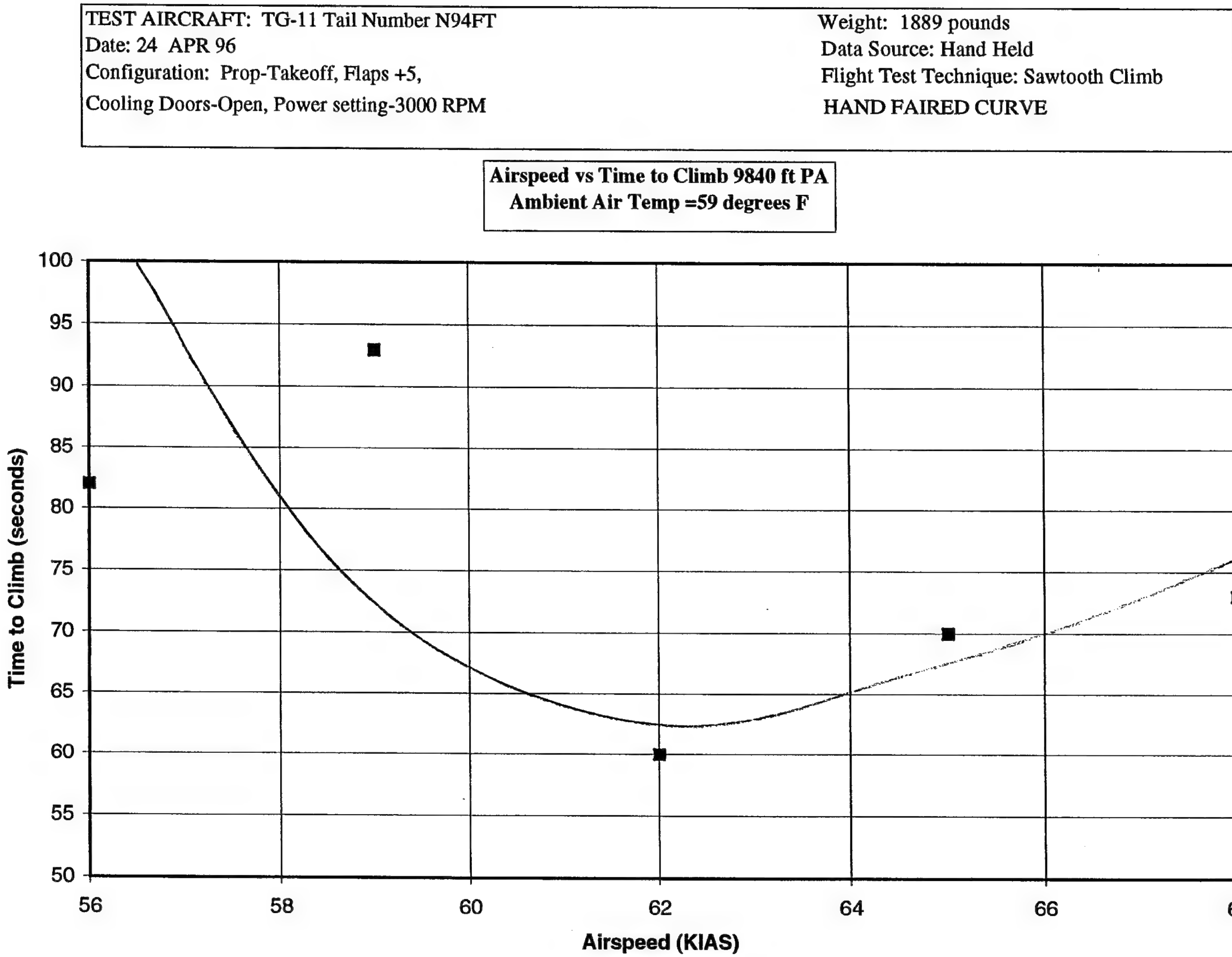


Figure C9 Best Speed to Climb, 9840 ft PA, Flight 3

Table C2
STANDARDIZED RATE OF CLIMB RESULTS, 3,280 FEET (3,000 RPM)

Rate of Climb (fpm), 62 kt, 3,000 rpm, Target Altitude 3,280 ft							
	Altitude Increment (ft)						
	3,110 - 3,440[1]	3,220 - 3,440	3,330 - 3,440	3,110 - 3,330	3,220 - 3,330	3,110 - 3,220	Average ROC
Flight 1	437	439	400	460	513	432	446
Flight 2	351	337	381	339	300	383	349
Flight 3	326	345	331	324	338	290	326
Flight 4	289	289	299	284	293	289	291
Flight 5	348	337	319	366	354	378	350
Flight 6	339	358	351	333	384	307	345
Flight 7	362	358	414	339	343	370	364

[1] 1-minute altitude increment

Table C3
STANDARDIZED RATE OF CLIMB RESULTS, 6,560 FEET (3,000 RPM)

Rate of Climb (fpm), 62 kt, 3,000 rpm, Target Altitude 6,560 ft							
	Altitude Increment (ft)						
	6,400 - 6,700[1]	6,500 - 6,700	6,600 - 6,700	6,400 - 6,600	6,500 - 6,600	6,400 - 6,500	Average ROC
Flight 1	330	287	301	346	271	459	332
Flight 2	312	338	336	301	317	266	312
Flight 3	317	338	365	298	294	279	315
Flight 4	286	333	341	266	302	220	291
Flight 5	266	252	253	272	248	298	265
Flight 6	313	321	321	309	318	298	313
Flight 7	317	319	349	302	310	313	318

[1] 1-minute altitude increment

Table C4
STANDARDIZED RATE OF CLIMB RESULTS, 9,840 FEET (3,000 RPM)

Rate of Climb (fpm), 62 kt, 3,000 rpm, Target Altitude 9,840							
	Altitude Increment (ft)						
	9,680- 9,920[1]	9,760- 9,920	9,840- 9,920	9,680- 9,840	9,760- 9,840	9,680- 9,760	Average ROC
Flight 1	214	222	265	196	164	197	210
Flight 2	243	247	277	229	222	235	245
Flight 3	241	222	190	278	300	282	252
Flight 4	180	170	175	182	180	199	181
Flight 5	246	274	290	229	257	208	251
Flight 6	144	141	139	147	128	153	142
Flight 7	230	240	284	208	221	214	233

[1] 1-minute altitude increment

TEST AIRCRAFT: TG-11 Serial Number 940004
Date: 8-26 APR 96
Configuration: Prop-Takeoff, Flaps +5,
Cooling Doors-Open, Power setting-3000 RPM

Weight: 1874 pounds
Data Source: Hand Held
Flight Test Technique: Sawtooth Climb

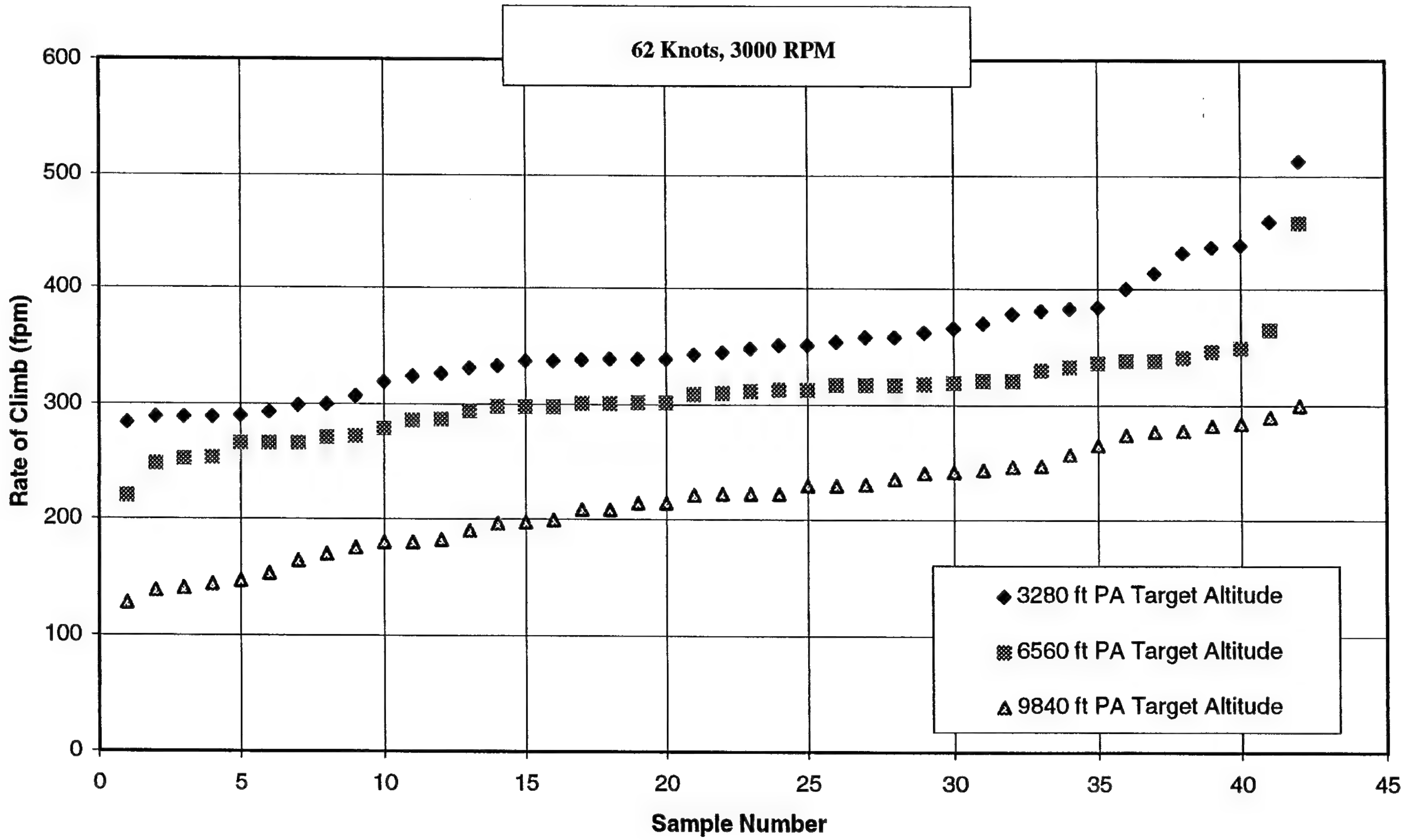


Figure C10 Rate of Climb Variation, 3000 RPM

Table C5
STANDARDIZED RATE OF CLIMB, 3,280 FEET (FULL THROTTLE)

Rate of Climb (fpm), 62 kt, Full Throttle (3,200 rpm), Target Altitude 3280 ft							
Altitude Increment (ft)							
	3,110-3,440[1]	3,220-3,440	3,330-3,440	3,110-3,330	3,220-3,330	3,110-3,220	Average ROC
Flight 1	413	425	443	400	407	391	413
Flight 2	405	439	391	412	494	350	415

[1] 1-minute altitude increment

Table C6
STANDARDIZED RATE OF CLIMB, 6,560 FEET (FULL THROTTLE)

Rate of Climb (fpm), 62 kt, Full Throttle (3,200 rpm), Target Altitude 6,560 ft							
Altitude Increment (ft)							
	6,400-6,700[1]	6,500-6,700	6,600-6,700	6,400-6,600	6,500-6,600	6,400-6,500	Average ROC
Flight 1	308	318	330	298	327	291	312
Flight 2	346	327	291	380	365	391	350

[1] 1-minute altitude increment

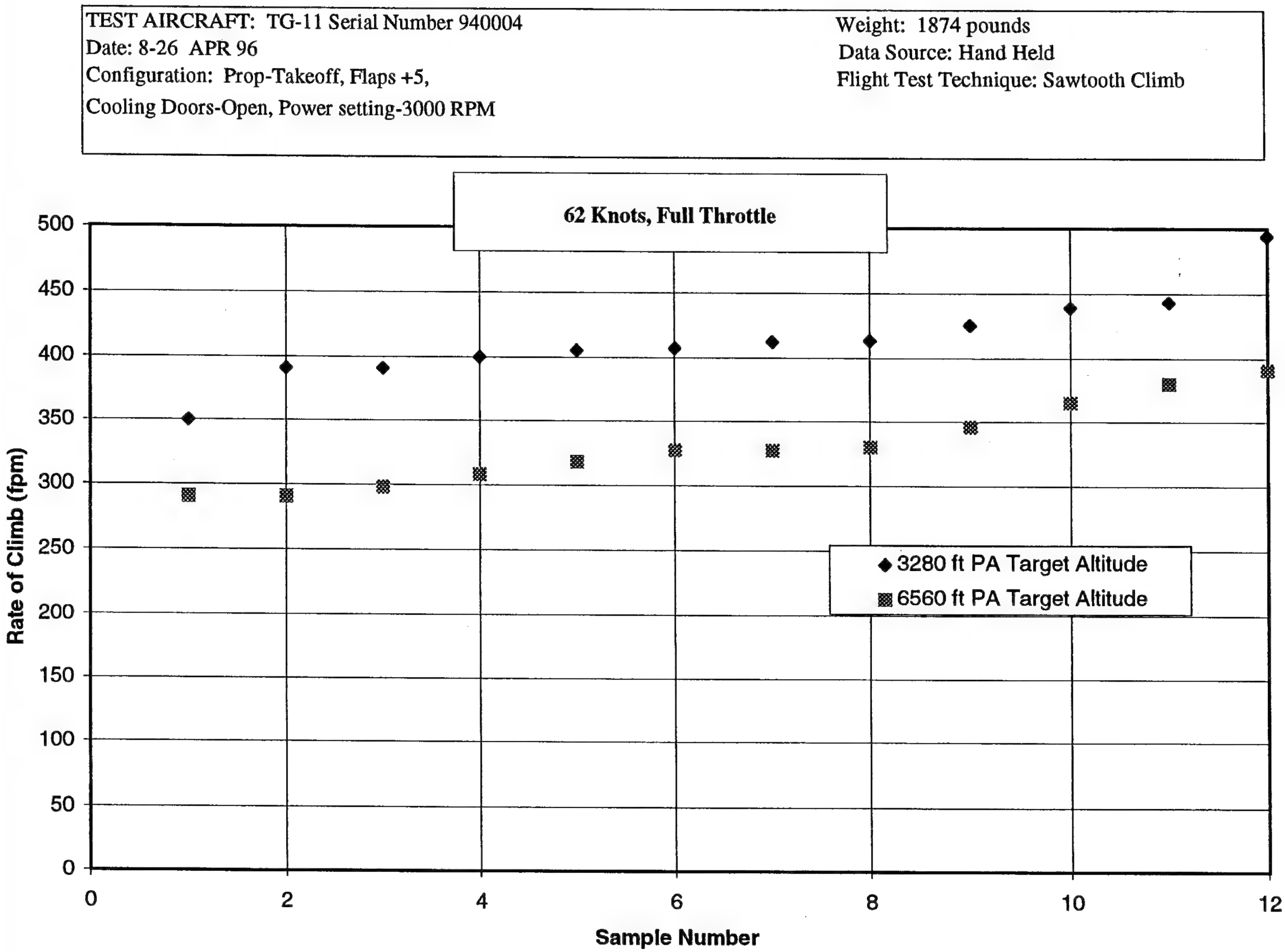


Figure C11 Rate of Climb Variation, Full Throttle

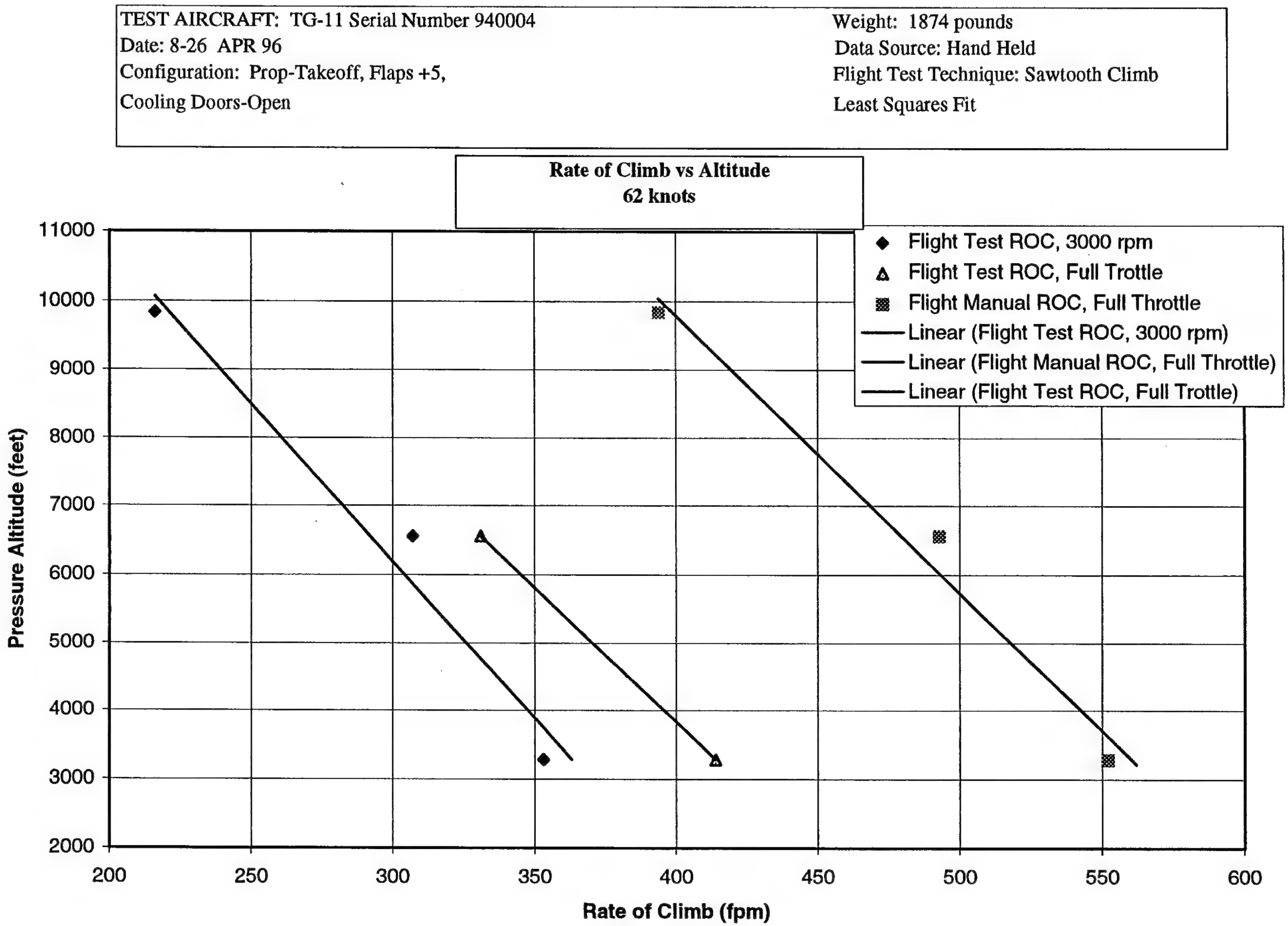


Figure C12 Rate of Climb vs Altitude, Flight Test Data and Flight Manual

This page intentionally left blank.

APPENDIX D

ENGINE LOSS AFTER ALTITUDE AND ALTITUDE LOSS FOR ENGINE START DATA

This page intentionally left blank.

Table D1
ENGINE OUT PATTERN RAW DATA

Test Point	Bank Angle	Engine	Prop Condition	Start Alt (ft)	Start Airspeed (KCAS)	Start Airspeed (KTAS)[1]	Temp (deg F)	Finish Alt (ft)	Finish Airspeed (KCAS)	Finish Airspeed (KTAS)[1]
1	30	idle	windmill	7,200	57	65	55	7,040	56	64
2	30	idle	windmill	7,000	57	65	57	6,820	56	64
5	30	idle	windmill	7,200	57	64	50	7,000	57	64
6	30	idle	windmill	6,900	57	64	50	6,700	56	63
9	30	idle	windmill	7,200	57	65	60	7,000	57	65
10	30	idle	windmill	6,900	57	65	60	6,700	58	66
3	45	idle	windmill	6,700	57	64	57	6,560	55	62
4	45	idle	windmill	6,500	57	64	59	6,400	55	62
7	45	idle	windmill	6,600	57	64	51	6,500	57	64
8	45	idle	windmill	6,400	57	64	51	6,250	57	64
11	45	idle	windmill	6,600	57	64	62	6,450	57	64
12	45	idle	windmill	6,400	57	64	64	6,300	57	64
13	45	idle	windmill	7,200	57	65	66	7,040	59	68
14	45	idle	windmill	6,900	57	65	66	6,780	56	64
15	45	idle	windmill	6,600	57	65	66	6,480	58	66
16	45	idle	windmill	6,400	57	65	68	6,280	57	65
17	45	idle	windmill	7,200	57	65	53	7,060	57	65
18	45	idle	windmill	7,000	57	64	53	6,880	57	64
19	45	idle	windmill	6,800	57	64	53	6,680	57	64
20	45	idle	windmill	6,600	57	64	53	6,490	57	64
22	45	idle	windmill	6,700	57	65	64	6,580	57	65
23	45	idle	windmill	6,500	57	65	64	6,400	58	66
24	45	idle	windmill	6,300	57	64	64	6,180	57	64
28	45	off	windmill	7,300	57	66	66	7,220	56	64
29	45	off	windmill	6,240	57	64	66	6,140	57	64
30	45	off	windmill	6,900	57	65	66	6,790	57	65
27	45	off	braked	6,400	57	64	64	6,300	56	63
31	45	off	braked	6,800	57	65	66	6,740	57	65
32	45	off	braked	6,580	57	65	66	6,480	59	67
33	45	off	braked	6,400	57	65	66	6,340	57	65
34	45	off	braked	6,400	57	65	66	6,320	59	67
25	60	idle	windmill	7,200	57	65	62	7,100	54	62

[1]True airspeed determined using equation 5.51 of Reference 4:

$V_{true} = V_{equivalent} /(s)^{\wedge}1/2$

Where:

$V_{equivalent}$ = $V_{calibrated}$ for low airspeeds

s = Density ratio = d/ q

d = Pressure ratio = $(1-6.87558\text{x}10^{-6} \text{ X Pressure Altitude})^{5.2559}$

q = Temperature ratio = $T_{ambient}$ (deg R)/518.7

Table D2
ENGINE OUT PATTERN ALTITUDE LOSS STANDARDIZATION

Test Point	Bank Angle	Engine/ Prop	Raw Altitude Loss (ft)	Corrections: Temp (ft)[1]	Corrections: Airspeed (ft)[2]	Corrected Altitude Loss (ft)	Avg (ft)	Std Dev (ft)
1	30	idle	160	7	7	174		
2	30	idle	180	8	6	195		
5	30	idle	200	7	0	207		
6	30	idle	200	6	6	213		
9	30	idle	200	11	0	211		
10	30	idle	200	10	-7	204	200	15
3	45	idle	140	6	13	159		
4	45	idle	100	5	13	117		
7	45	idle	100	3	0	103		
8	45	idle	150	4	0	154		
11	45	idle	150	8	0	158		
12	45	idle	100	6	0	106		
13	45	idle	160	11	-13	157		
14	45	idle	120	8	7	134		
15	45	idle	120	7	-7	121		
16	45	idle	120	8	0	128		
17	45	idle	140	6	0	146		
18	45	idle	120	5	0	125		
19	45	idle	120	4	0	124		
20	45	idle	110	4	0	114		
22	45	idle	120	7	0	127		
23	45	idle	100	6	-6	99		
24	45	idle	120	7	0	127	129	19
28	45	off/windmill	80	5	7	92		
29	45	off/windmill	100	6	0	106		
30	45	off/windmill	110	7	0	117	105	13
27	45	off/braked	100	6	6	112		
31	45	off/braked	60	4	0	64		
32	45	off/braked	100	6	-13	93		
33	45	off/braked	60	4	0	64		
34	45	off/braked	80	5	-13	72	81	21
25	60	idle	100	6	20	126	126	-----

[1]The correction for test day ambient air temperature difference from standard day was (Equation 5.28, Reference 4):

$$\Delta h = (T_a/T_{sd})\,\Delta h_c$$

Where:

Δh = Geopotential (actual) altitude change
Δh_c = pressure altitude change
T_{sd} = Standard day ambient air temperature
T_a = Test day ambient air temperature

[2]The correction for airspeed changes was (Equation 9.11, Reference 5):

$$\frac{dE_s}{dt} = \frac{dh}{dt} + \frac{VdV}{gdt}$$

Where:

E_s = Energy (Sum of kinetic and potential energy)
h = Geopotential altitude
V = True airspeed
g = Acceleration due to gravity

This equation was used to determine total energy change of the aircraft and was then solved for a constant true airspeed descent by setting the dV/dt term equal to zero.

Table D3
ALTITUDE LOSS FOR ENGINE START RAW DATA

Test Point	Time (min)	Start Altitude (ft)	Start Airspeed (KCAS)	Start Airspeed (KTAS)[1]	Temp (deg F)	Finish Altitude (ft)	Finish Airspeed (KCAS)	Finish Airspeed (KTAS)[1]
1	2.07	9,600	62	73	44	9,000	62	73
2	2.17	9,800	62	73	44	9,200	59	69
3	1.92	9,840	62	73	44	9,420	62	73
4	2.42	7,000	62	70	51	6,400	62	70
5	1.85	6,600	62	70	62	5,900	58	65
6	3.22	6,600	62	70	68	5,800	62	70
7	2.1	4,300	62	67	68	3,900	62	67
8	----	4,300	62	67	68	3,900	62	67

[1]True airspeed determined using equation 5.51 of Reference 4:

V_{true} = $V_{equivalent}$ /(s)^1/2

Where

$V_{equivalent}$ = $V_{calibrated}$ for low airspeeds
s = Density ratio = d/ q
d = Pressure ratio = $(1-6.87558\text{x}10^{-6} * \text{Pressure Altitude})^{5.2559}$
q = Temperature ratio = $T_{ambient}$ (deg Rankine)/518.7

Table D4
ALTITUDE LOSS FOR ENGINE START DATA STANDARDIZATION

Test Point	Average Altitude (ft, PA)	Raw Altitude Loss (ft)	Corrections: Nonstandard Temperature (ft)[1]	Corrections: Airspeed Deviations (ft)[2]	Corrected Altitude Loss (ft)	Average Sink Rate (ft/min)	Average Altitude Loss (ft)	Standard Deviation
1	9,300	600	24	0	624	301		
2	9,500	600	25	23	648	298		
3	9,630	420	17	0	437	228	570	115
4	6,700	600	21	0	621	256		
5	6,250	700	38	28	765	414		
6	6,200	800	53	0	853	265	746	117
7	4,100	400	19	0	419	200		
8	4,100	400	19	0	419	----	419	0
						Total	598	163

[1]The correction for test day ambient air temperature difference from standard day was (Equation 5.28, Reference 4):

$$\Delta h = (T_a/T_s)\,\Delta h_c$$

Where:

Δh = Geopotential (actual) altitude change
Δh_c = pressure altitude change
T_s = Standard day ambient air temperature
T_a = Test day ambient air temperature

[2]The correction for airspeed changes was (Equation 9.11, Reference 5):

$$\frac{dE_s}{dt} = \frac{dh}{dt} + \frac{VdV}{gdt}$$

Where:

E_s = Energy (Sum of kinetic and potential energy)
h = Geopotential altitude
V = True airspeed
g = Acceleration due to gravity

This equation was used to determine total energy change of the aircraft and was then solved for a constant true airspeed descent by setting the dV/dt term equal to zero.

APPENDIX E

RAW CRUISE DATA AND REDUCTION

This page intentionally left blank.

CRUISE DATA REDUCTION PROCEDURES

STANDARDIZATION OF FUEL FLOW

Standardization was in accordance with the USAF Test Pilot School's *Performance Flight Test Phase Textbook, Chapter 11, Cruise Performance Theory* (Reference 7). It is valid for a given engine rpm within ± 2,000 feet of altitude and ± 2 percent of the aircraft's weight. The equations below present the standardization of fuel flow and the development for the standardization of specific range.

$$ff_s = (ff / \delta * \theta^{1/2})_t * (\delta * \theta^{1/2})_s$$

Where:

ff_s = Fuel flow at standard altitude

ff_t = Fuel flow at test day conditions

δ_s = Ambient air pressure ratio at standard altitude

δ_t = Ambient air pressure ratio at test day conditions

θ_s = Ambient air temperature ratio at standard altitude

θ_t = Ambient air temperature ratio at test day conditions

STANDARDIZATION OF SPECIFIC RANGE CALCULATIONS

$$SR_s = V_{ts} / ff_s$$

Where:

Sr_s = Specific range at standard altitude

V_{ts} = True velocity at standard altitude

ff_s = Fuel flow at standard altitude

$$SR_s = V_{ts}/[(ff/\delta*\theta^{1/2})_t * (\delta*\theta^{1/2})_s]$$

$$SR_s = [V_{ts}/ff_t]*(\delta_t/\delta_s) * (\theta_t/\theta_s)^{1/2}$$

Where:

$(\theta_t / \theta_s)^{1/2} = a_t / a_s$

a_t = Local test day speed of sound

a_s = Local standard day speed of sound

$$SR_s = (V_{tt}/ff_t)*(M_s/M_t) * (\delta_t/\delta_s)$$

$$SR_s = SR_t * (\delta_t/\delta_s) \text{ (Only if } M_s = M_t)$$

Where:

M_t = Local test day Mach number

M_s = Local standard day Mach number

V_{tt} = True velocity at test day conditions

Sr_t = Specific range at test day conditions

Note: For $M_s = M_t$, $V_{ts} \neq V_{tt}$ due to the change in the ambient air temperature and therefore a change in the local speed of sound.

RAW CRUISE DATA AND REDUCTION

Table E1 contains the raw cruise data and data reduction for samples taken between 9 and 29 April 1996 at the Air Force Flight Test Center, Edwards AFB, CA. The spreadsheets utilized the formulas listed in this Appendix. Calculations were rounded to the nearest significant figure consistent with instrument accuracy.

Table E1
TG-11 CRUISE DATA AND STANDARDIZATION TO 8,500 FEET STANDARD DAY CONDITIONS
TEST DATE: 9 THROUGH 25 APR 96
LOCATION: EDWARDS AFB, CA

Sortie Number	Date	Pressure Altitude (ft)	Ambient Air Temperature (deg F)	Ambient Air Temperature (deg R)	Equivalent Airspeed (kt)	True Airspeed (kt)	Fuel Flow (gal/hr)	Pressure Ratio	Temp Ratio	Density Ratio	Standard Fuel Flow (gal/hr)	Specific Range (NAM/gal)	Standard Specific Range (NAM/gal)
1	9-Apr-96	8,600	53	513	86	100	4.5	0.7259	0.9890	0.7340	4.4	22	22
2	11-Apr-96	8,530	50	510	84	98	4.5	0.7278	0.9832	0.7403	4.4	22	22
3	11-Apr-96	8,510	50	510	83	96	4.2	0.7284	0.9832	0.7408	4.1	23	23
4	22-Apr-96	8,480	53	513	85	99	4.2	0.7292	0.9890	0.7374	4.1	24	24
5	22-Apr-96	8,510	53	513	85	99	4.2	0.7284	0.9890	0.7365	4.1	24	24
6	23-Apr-96	8,515	57	517	87	102	4.6	0.7283	0.9967	0.7307	4.5	22	22
7	23-Apr-96	8,510	57	517	84	98	4.4	0.7284	0.9967	0.7308	4.3	22	22
8	25-Apr-96	8,500	64	524	84	99	4.4	0.7287	1.0102	0.7213	4.2	22	22
9	25-Apr-96	8,550	64	524	86	101	4.4	0.7273	1.0102	0.7199	4.3	23	23

APPENDIX F

FIGURES/PHOTOS

This page intentionally left blank.

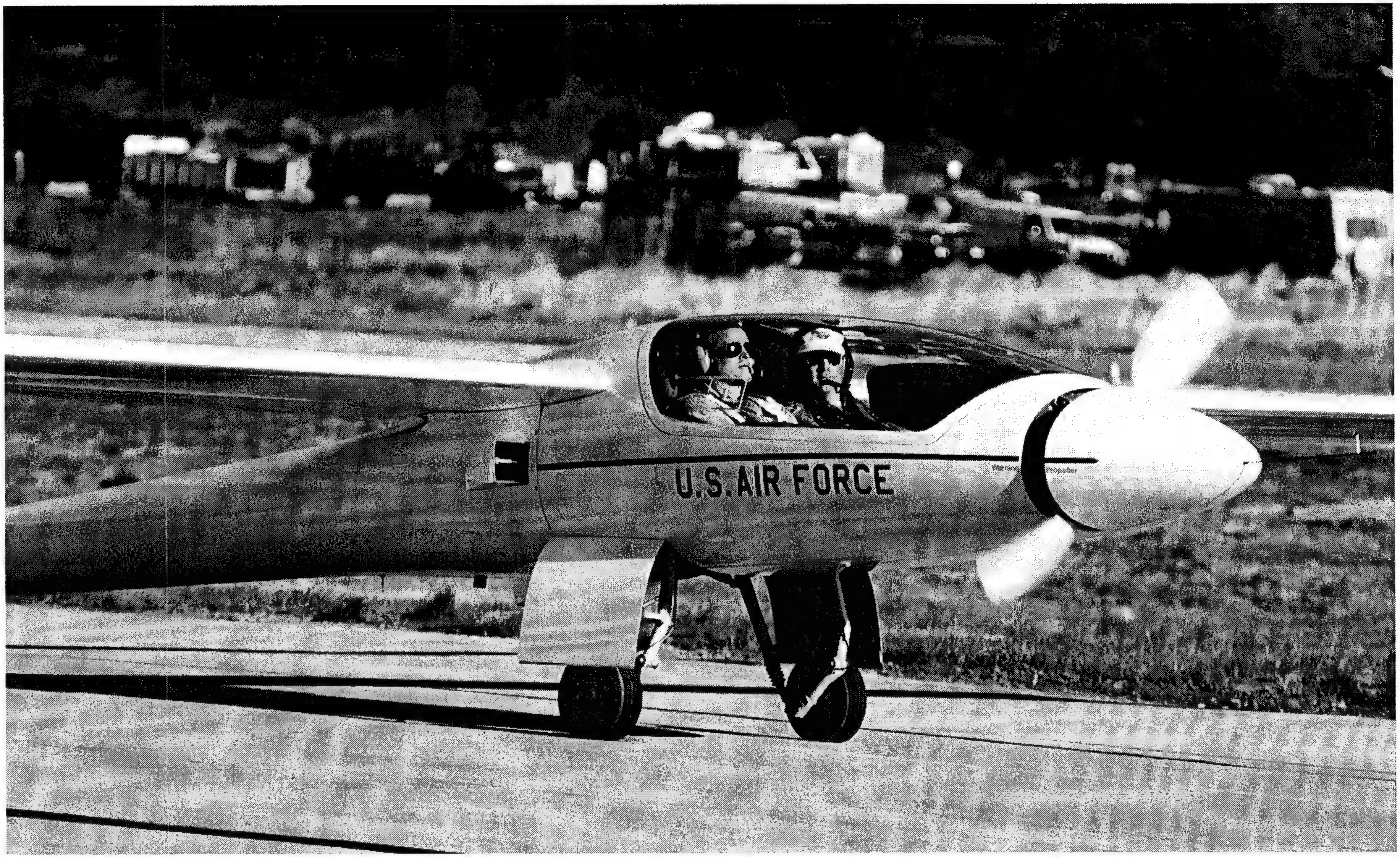


Figure F1 TG-11 Aircraft Taxiing at Big Bear City Airport, California

Figure F2 Test Team in Front of the TG-11 Aircraft

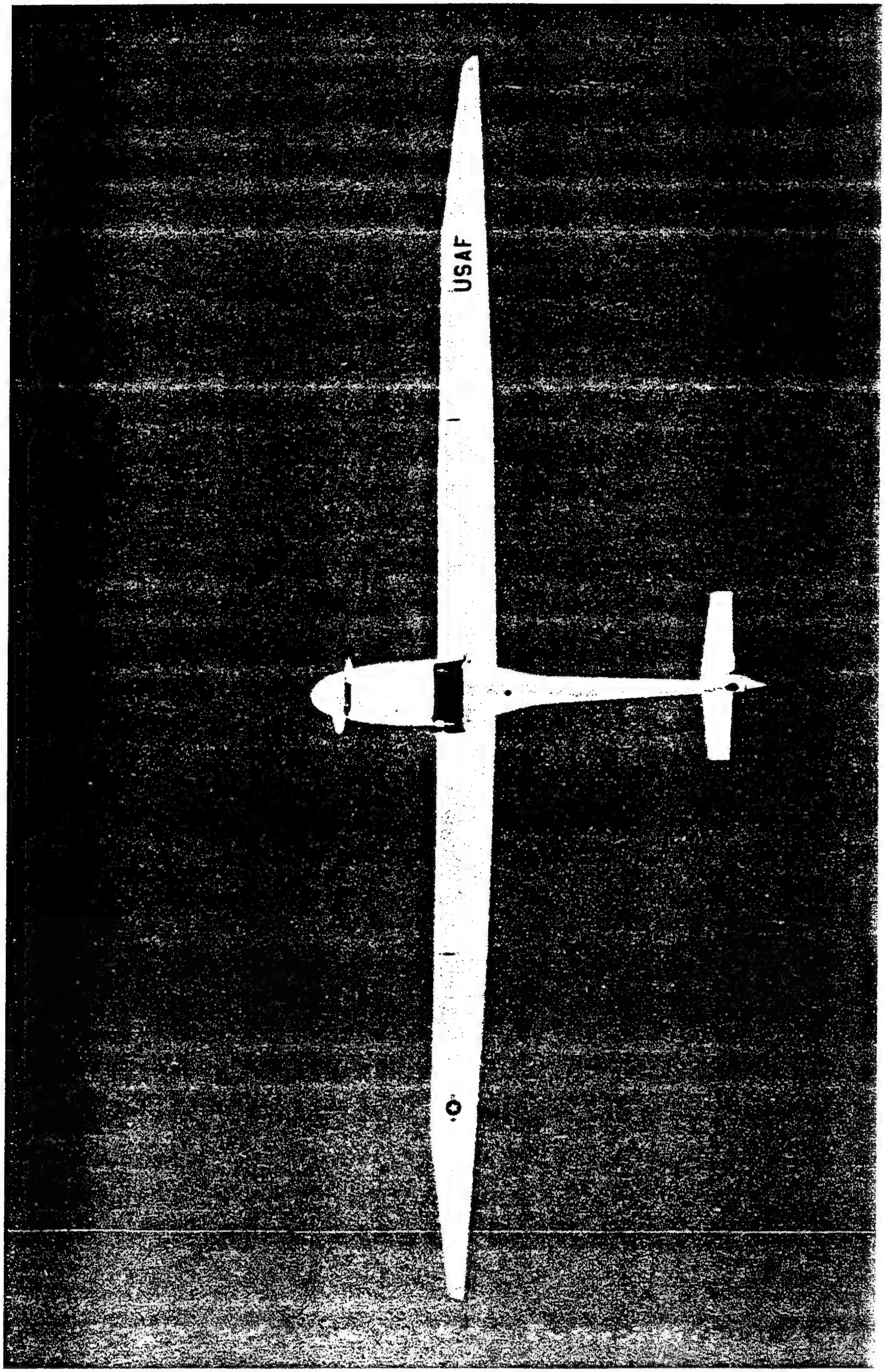


Figure F3 TG-11 in the Pattern, Big Bear City Airport, California

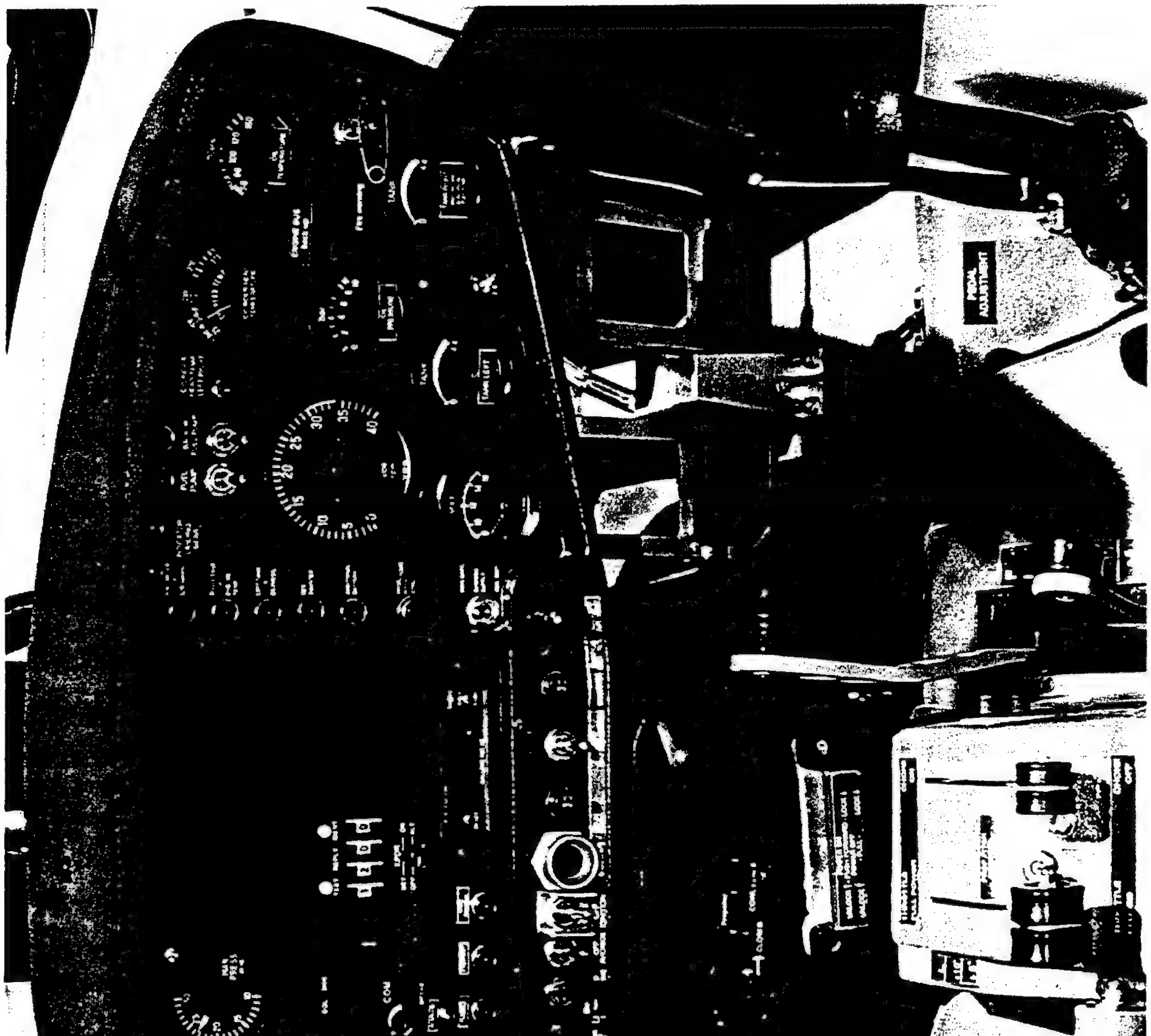


Figure F4 Cockpit Photo

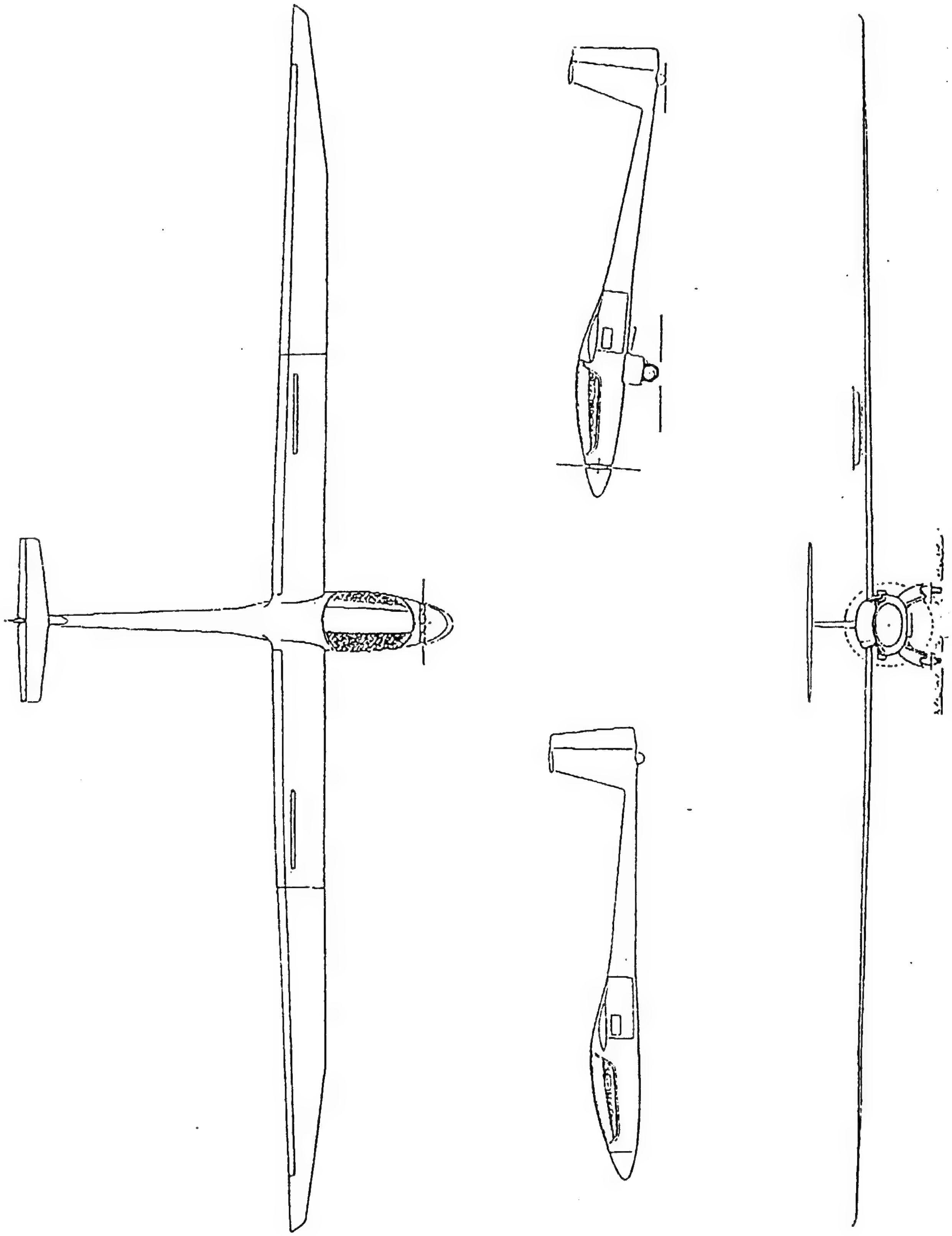


Figure F5 Overview of the TG-11 Aircraft

This page intentionally left blank.

APPENDIX G

PILOT'S INITIAL DAILY REPORTS

This page intentionally left blank.

DAILY/INITIAL FLIGHT TEST REPORT

1. AIRCRAFT TYPE	2. SERIAL NUMBER
TG-11, STEMME S10	N94FT

3. CONDITIONS RELATIVE TO TEST

A. PROJECT / MISSION NO	B. FLIGHT NO / DATA POINT	C. DATE
...VE CHRYSALIS	THIS WAS FLIGHT: CF1	3 APRIL 96
...NT COCKPIT (*Left Seat*)	**E. FUEL LOAD**	**F. JON**
..AJ HOWELL	16 GALLONS AVIATION GAS (100 LL)	M96J0200
G. REAR COCKPIT (*Right Seat*)	**H. START UP GR WT / CG**	**I. WEATHER**
MAJ ROLLINGER	1874 POUNDS /	CLEAR, WIND 240 / 10 G 19
J. TO TIME / SORTIE TIME	**K. CONFIGURATION / LOADING**	**L. SURFACE CONDITIONS**
1140 (L) / 1.7 HOURS	CLEAN / FULLY LOADED (2 CREW)	DRY
M. CHASE ACFT / SERIAL NO	**N. CHASE CREW**	**O. CHASE TO TIME / SORTIE TIME**
NA	NA	NA

4. PURPOSE OF FLIGHT / TEST POINTS

The purpose of this flight was to introduce Maj. Rollinger to the TG-11. Takeoff was performed from South base runway 24. We flew several patterns at 5 degrees flaps to both stop and go and touch and go. We performed high work between 6,500'- 8,500' that included: coordinated turns, power on stalls, transition to cruise, engine shut down, thermaling, power off stalls and engine restart. Recovery was flown to lakebed runway 24.

5. RESULTS OF TESTS (*Continue on reverse if needed*)

GENERAL. The aircraft is very susceptible to atmospheric disturbances. We experienced light, but gusty cross winds and thermals close to the ground.

SPECIFIC COMMENTS ON DATA QUALITY. No data collection was attempted this flight.

COMMENTS ON HANDLING QUALITIES. Taxi is not difficult as long as the speed is kept slow. I had my hands full trying to hold the spoilers full open while holding the stick full aft and managing the throttle. *Recommend that taxiing in more than light winds be made a crew task (R1).* Turn radius is large. Wing clearance was easy using the shadow from a high sun.

Takeoff was not difficult, having had recent tail wheel experience. On the rotation my nose yawed right into a light cross wind. I feel that I applied too much right pedal pressure as I expected the nose to yaw left with the nose down rotation. The desire to climb out in the takeoff attitude must be overcome as it takes a more nose down attitude to accelerate to 62 knots for the climb out.

The stop and go landing was high work load, especially directional and lateral control. I liked landing it with the power at idle like you would land a glider (hand on the spoilers). The was a lot of lag apparent in the roll axis. The rudders were very effective and no lag was noticed.

Touch and go landings were the most difficult, having to move my hand from the spoilers to the throttle, then back to the spoilers, then back to the throttle. Once again slow lateral control was noticed, while the rudders provided excellent directional control. On one landing the left wing was lifted (possible themal) and the pilot was slow to counter with full left aileron. The instructor applied full left aileron and took control of the aircraft but the right wingtip scraped the runway. This was not noticed until post flight. *Recommend that the USAFA attach scrape pads or scrape strips under the wingtips to prevent structural damage due to wingtips contacting the runway (R1).* The aircraft is noticeably underpowered.

In the climb, precise airspeed control was difficult as we got bumped around a little. The power on stalls tended to develop sideslip that we needed to counter with full rudder pedal deflection. I found that bank to bank turns were difficult to coordinate. I tried to lead the aileron with rudder (like I would in the ASK) and found that this resulted in a skid. The roll rate is so slow that even a little opposite rudder may be necessary until the roll rate builds and the AOB is reversed. I need more work learning to coordinate turns. I used too much rudder into the turn to attempt to get the nose tracking the way I wanted it to go. This resulted in the skid. *Ensure that the USAFA syllabus emphasizes turn coordination exercises (R2).* While performing steep banked turns I found an insidious overbanking tendency. Once established in an AOB the aircraft requires lateral stick away from the turn to keep from increasing the AOB further. *Ensure the USAFA syllabus incorporates training to prevent unusual attitudes from an overbanked turn (R3).*

Airborne engine shutdown and start were simple and straight forward to accomplish.

6. RECOMMENDATIONS

1. *Recommend that the USAFA attach scrape pads or scrape strips under the wingtips to prevent structural damage due to wingtips contacting the runway.*
2. *Recommend that taxiing in more than light winds be made a crew task.*
3. *Ensure that the USAFA syllabus emphasizes turn coordination exercises.*
4. *Ensure the USAFA syllabus incorporates training to prevent unusual attitudes from an overbanked turns.*

...ETED BY	SIGNATURE	DATE
MAJ ROLLINGER, USMC		3 APR 96

AFSC Form 5314 NOV 86 REPLACES AFFTC FORM 365 MAR 84 WHICH WILL BE USED

DAILY/INITIAL FLIGHT TEST REPORT

1. AIRCRAFT TYPE	2. SERIAL NUMBER
TG-11, STEMME S10	N94FT

3. CONDITIONS RELATIVE TO TEST

A. PROJECT / MISSION NO HAVE CHRYSALIS	B. FLIGHT NO / DATA POINT THIS WAS FLIGHT: T1	C. DATE 9 APRIL 96
D. FRONT COCKPIT *(Left Seat)* MAJ HOWELL	E. FUEL LOAD GALLONS AVIATION GAS (100 LL)	F. JON M96J0200
G. REAR COCKPIT *(Right Seat)* MAJ ROLLINGER	H. START UP GR WT / CG 1874 POUNDS /	I. WEATHER CALM WIND
J. TO TIME / SORTIE TIME 0740 (L) / 0.8 HOURS	K. CONFIGURATION / LOADING CLEAN / FULLY LOADED (2 CREW)	L. SURFACE CONDITIONS DRY
M. CHASE ACFT / SERIAL NO NA	N. CHASE CREW NA	O. CHASE TO TIME / SORTIE TIME NA

4. PURPOSE OF FLIGHT / TEST POINTS

The purpose of this flight was to gather takeoff data and get Maj Rollinger landing practice. We accomplished 7 takeoffs and landings. On the last two takeoffs the wind started to kick up (tower reported 220/09) and the data will be suspect. The ground crew consisted of Capts Hughes (Test Conducter), Folcik and Skelton (Guest help).

5. RESULTS OF TESTS *(Continue on reverse if needed)*

GENERAL. Test technique was to hold the brakes while full power was applied and then release brakes. The pilot called out to Maj Howell the RPM and Manifold pressure at brake release. The aircraft was rotated nose down at 35 knots and allowed to lift off at 45 knots. The plane was then accelerated at approximately 10' altitude to 56 knots (best climb angle speed). Then the pilot pulled the nose up to maintain 56 knots in the climb. The landing gear was not raised after takeoff.

SPECIFIC COMMENTS ON DATA QUALITY. The takeoffs were consistent with the following minor exceptions noted. On run number one the aircraft drifted right of centerline between lift off and attaining 50' altitude. I estimate that we were 15-20 right of centerline as we passed the pickup truck. On takeoffs number six and seven tower reported higher winds (220/09) and I felt that it took less time to get to 50' because of this, even though our ground crew didn't see this much wind. There were slight inconsistencies after airborne as the pilot attempted to get to the proper attitude for acceleration and then the climb at 56 knots. The acceleration phase took place between 5' and 15' above the runway.

COMMENTS ON HANDLING QUALITIES. This was Maj Rollinger's second flight. The most noticeable traits of this aircraft in the landing pattern are its *slow roll response* and what I perceived as awkward or *unnatural turn coordination*. The new pilot must scan the yaw string more often than normal to stay coordinated. The aircraft gains speed rapidly when it is nose down in the landing pattern. As Capt Baysinger noted, it is very easy to assault the 76 knot gear down speed limit if the airspeed is not constantly cross checked.

6. RECOMMENDATIONS

COMPLETED BY	SIGNATURE	DATE
MAJ ROLLINGER	[signature]	9 APR 96

AFSC Form 5314 NOV 86 REPLACES AFFTC FORM 365 MAR 84 WHICH WILL BE USED

DAILY/INITIAL FLIGHT TEST REPORT

1. AIRCRAFT TYPE	2. SERIAL NUMBER
Stemme S-10V (TG11)	N94FT

3. CONDITIONS RELATIVE TO TEST

A. PROJECT / MISSION NO	B. FLIGHT NO / DATA POINT	C. DATE
CF-1	Ops #3379	2 APR 96
D. FRONT COCKPIT *(Left Seat)*	E. FUEL LOAD	F. JON
Capt Baysinger	13Gallons AvGas	M96J0200
G. REAR COCKPIT *(Right Seat)*	H. START UP GR WT / CG	I. WEATHER
Dave Lazerson	~1860 Pounds	Clear
J. TO TIME / SORTIE TIME	K. CONFIGURATION / LOADING	L. SURFACE CONDITIONS
1030 (L) / 1.0 HOURS	Clean	Winds 270 10G18
M. CHASE ACFT / SERIAL NO	N. CHASE CREW	O. CHASE TO TIME / SORTIE TIME
N/A	N/A	N/A

4. PURPOSE OF FLIGHT / TEST POINTS

This was the first checkout flight for the HAVE CHRYSALIS TMP in the Stemme motorglider. Events consisted of Ground Ops, Takeoff, Power on and off maneuvering and stalls, transition between powered and unpowered flight, VFR arrival and patterns at Southbase (No flap, Full Flap, +5 flap, slips, and high altitude go around).

GENERAL The cockpit, even for a smaller dimension person, is somewhat tight. With the stick at full lateral deflections required while taxiing it is difficult to effectively actuate the brakes and inadvertent actuation of the radio mike is very easy. In addition, it is rather difficult to get to the flap lever.

SPECIFIC COMMENTS ON DATA QUALITY. No data taken on this flight.

COMMENTS ON HANDLING QUALITIES. Taxiing was easier than anticipated since shadows can easily be used to judge wingtip location. Tail wheel steering requires some anticipation, but is very effective. If winds require the use of spoilers on the ground taxiing becomes a two person operation since the spoilers must be constantly held open.

As with most taildraggers, directional control on takeoff was not too difficult but did require constant attention so it was convenient to have the other pilot call out airspeeds (35 to rotate, 46 to takeoff). During tailwheel familiarization on the Cessna 150, I had become accustomed to needing right rudder on rotation, so I overcompensated and put in too much right rudder. **Recommend USAFA syllabus point out that gyroscopic effects on the runway are minimal.**

Airwork in the Stemme was fairly straightforward. The controls do not have very good harmony since pitch is fairly sensitive but roll is rather sluggish and full deflection roll rates leave something to be desired. In addition, it appears that the rudder is more powerful in this airplane than the ASK or GROB gliders. Less rudder is required rolling into and out of turns than was expected. Turns using greater than 45 degrees of bank are difficult to accomplish since there is a strong tendency for the airplane to continue to roll into more bank and drop the nose. Lazy eights are good maneuvers for control coordination. **Recommend USAFA syllabus includes Lazy eight and steep turn training.**

Patternwork in the Stemme is challenging. The margin between pattern airspeeds and gear limiting speed is between 10 and 15 knots (depending on winds). This is a very tight margin for an airplane that is highly sensitive to wind gusts and care must be taken not to overspeed the gear on bumpy days. Proper coordination becomes critical on the turn to final. Several times, when I overanticipated with the rudder in the final turn I ended up slipping or skidding the airplane because I had too much rudder in and the nose stopped tracking through the turn. This could cause overshoots and definitely complicates the runway alignment solution. It was very difficult to overcome the tendency to point the nose to correct for high/low pattern corrections. It was also uncomfortable to fully flare the airplane since the forward visibility is not very good in the landing attitude. It was also somewhat disconcerting during the touch and go for the spoiler lever to reposition itself with power application. This caused some confusion when reaching to close the spoilers for takeoff. **Recommend USAFA syllabus includes thoroughly prebriefing control placements and reactions on the touch and go patterns.** Very little difference was noted between the patterns with different flap settings with the exception that the full flap configuration took off immediately after closing the spoiler on the touch and go below 46 knots.

6. RECOMMENDATIONS

COMPLETED BY	SIGNATURE	DATE
Capt D. Brent Baysinger		2 APR 96

AFSC Form 5314 NOV 86 REPLACES AFFTC FORM 365 MAR 84 WHICH WILL BE USED

This page intentionally left blank.

LIST OF ABBREVIATIONS, ACRONYMS, AND SYMBOLS

Abbreviations	Definition	Unit
Δh	geopotential (actual) altitude change	ft
Δh_c	pressure altitude change	ft
δ_s	ambient air pressure ratio at standard altitude	---
θ_s	ambient air temperature ratio at standard altitude	---
σ_s	density ratio at standard altitude	---
δ_t	ambient air pressure ratio at test day conditions	---
θ_t	ambient air temperature ratio at test day conditions	---
σ_t	density ratio at test conditions	---
A/S	airspeed	kt
AFB	Air Force Base	---
AFFTC	Air Force Flight Test Center	---
AGL	above ground level	---
alt	altitude	ft
deg	degree	---
E_s	specific energy (Sum of kinetic and potential energy)	ft
FAA	Federal Aviation Administration	---
FAR	Federal Aviation Regulation	---
ff_s	fuel flow at standard altitude	lb/hr
ff_t	fuel flow at test day conditions	lb/hr
fps	feet per second	---
ft	feet	---
g	acceleration due to Gravity	ft/sec^2
g	flight path angle	---
gal	gallon	---
h	geopotential altitude	ft
hr	hour	---
in Hg	inches of mercury	in

LIST OF ABBREVIATIONS, ACRONYMS, AND SYMBOLS (Continued)

Abbreviations	Definition	Unit
KCAS	knots calibrated airspeed	---
KIAS	knots indicated airspeed	---
KTAS	true airspeed	kt
kts	knots	---
lb	pound	---
max	maximum	---
MCP	maximum continuous power	---
min	minimum	---
M_s	local standard day Mach number	---
MSL	mean sea level	---
M_t	local test day Mach number	---
NAM	nautical air miles	---
NP	not performed	---
PA	pressure altitude	ft
rad	radian	---
ROC	rate of climb	ft/min
rpm	revolutions per minute	---
S_{atest}	test day air distance	ft
S_{awind}	air distance corrected for wind	ft
sec	second	---
S_{gs}	takeoff distance corrected to level runway	ft
S_{gstd}	standard, zero slope, zero wind ground run distance	ft
S_{gt}	test day ground run	ft
S_{gw}	takeoff distance corrected for wind	ft
SR_s	specific Range at standard altitude	nautical air miles per pound of fuel

LIST OF ABBREVIATIONS, ACRONYMS, AND SYMBOLS (Concluded)

Abbreviations	Definition	Unit
SR_t	specific range at test day conditions	nautical air miles per pound of fuel
t_{50}	time to travel test day air distance	sec
T_a	test day ambient air temperature	deg F
Temp	temperature	deg Ft
TPS	Test Pilot School	---
T_{sd}	standard day ambient air temperature	deg F
T_s	absolute ambient air temperature at standard altitude	Rankine
T_t	absolute ambient air temperature at test conditions	Rankine
USAF	United States Air Force	---
USAFA	USAF Academy	---
V	true airspeed	kt
V_c	calibrated airspeed	kt
V_{ic}	instrument corrected airspeed	kt
V_{max}	maximum speed at maximum thrust	kt
V_{sink}	sink rate	kt
V_t	true airspeed at liftoff	kt
V_T	true airspeed	kt
V_{true}	true airspeed	kt
Vts	true velocity at standard altitude	kt
V_{tt}	true velocity at test day altitude	kt
VVI	vertical velocity indicator	---
W	test day runway wind component (+ headwind, - tailwind)	kt
W_s	weight at standard conditions	lb
W_t	weight at test conditions	lb

This page intentionally left blank.

DISTRIBUTION LIST

Onsite Distribution	Number of Copies
AFFTC/HO 305 E Popson Ave, Bldg 1405 Edwards AFB CA 93524-6595	1
412 TW/TSTL 307 E. Popson Ave, Bldg 1400, Rm 106 Edwards AFB CA 93524-6630	3
USAF TPS/EDT Attn: Dave Lazerson 220 S Wolfe Avenue, Bldg 1220 Edwards AFB CA 93524-6485	10
USAF TPS/EDB Have Chrysalis Test Team Attn: Dave Lazerson 220 S Wolfe Avenue, Bldg 1220 Edwards AFB CA 93524-6485	5
412 TW/TSFC 195 E. Popson Ave, Bldg 2750 Edwards AFB CA 93524-6841	5
EAA Chapter 1000 c/o Norman E. Howell, Major, USAF USAF TPS/EDT 220 S Wolfe Ave Edwards AFB CA 93524	1
Offsite Distribution	
39 OG/CC Attn: LTC Randy Muncy 9211 Talon Drive USAFA, CO 80840	5
Defense Technical Information Center DTIC/OCC 8725 John J. Kingman Road, Suite 0944 Ft. Belvoir, VA 22060-6218	2
FASTC/TAA 4115 Pebble Creek Rd, Ste 23 Wright-Patterson AFB OH 45433-6508	1

DISTRIBUTION LIST (Concluded)

Offsite Distribution		Number of Copies
Stemme USA, Inc 200 South Brentwood Blvd #21B Saint Louis, MO 63105		2
STEMME GmbH & Co.Kg Attn: Dr Reiner Stemme Am Hugplatz 15344 Strausberg, Germany		2
	Total	37